MOVE AZ
Long Range Transportation Plan

Appendix G. Goods Movement in Arizona

MoveAZ Plan

prepared for

Arizona Department of Transportation

prepared by

Cambridge Systematics, Inc.

In association with

Lima & Associates

August 2004

ADOT

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1.0 Introduction

1.0 Introduction

This technical memorandum presents a summary of current goods movement and freight transportation needs and issues facing Arizona. This material was prepared to compliment the high-level assessment of freight activity that was presented in the Phase I: Strategic Directions Report of the Arizona Long-Range Transportation Plan (MoveAZ Plan). It provides a more detailed assessment of critical freight transportation issues and their relationship to transportation policy and infrastructure. The analysis was structured to examine industry and trade trends that influence freight transportation needs, and to examine the condition and performance of the state transportation system to meet freight needs.

The outcome of this analysis will provide ADOT with several broad themes that could guide future freight planning in Arizona. Other outcomes include:

- Identify the significant industries in Arizona that are most critically dependent on freight transportation;
- Examine how trends in these critical industries are likely to impact future demand on the state transportation system;
- Identify how future system performance might impact these critical industries;
- Understand freight transportation demand levels in the State and by mode;
- Develop a set of key indicators that describe the impact of freight traffic on the general performance of the state transportation system; and
- Identify the institutional environment (e.g., regulatory, policy, financial, etc.) that governs and directs transportation-dependent industries in Arizona.

Available data sources and information were used to support this analysis. Information from various economic development agencies in the State was collected to identify the industries contributing to the economic growth and health of Arizona. Available freight and commodity flow movement data sources, such as the Freight Analysis Framework (FAF) and Commodity Flow Survey (CFS) were used to supplement the information obtained from local agencies. In addition, information used to develop various elements of the MoveAZ Plan, such as the *Task 9 Demand and System Performance Technical Memorandum*, was used to prepare the material in this memorandum.

Sections 2.0 and 3.0 present overviews of goods movement with both the domestic and international economies, as well as into and out of Arizona. Section 4.0 summarizes logistics trends in the State, while Section 5.0 summarizes freight infrastructure and freight

demand flows by mode (trucks, rail, and air). Section 6.0 presents a brief overview of the institutional environment impacting goods movement in Arizona, and Section 7.0 presents the key findings of this analysis.

2.0 Goods Movement and the Domestic Economy

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2.1 Relationship of Goods Movement with State Economy

Goods movement is a critical part of the Arizona and national economy, both in terms of output and employment. Based on the most recent (1997) U.S. Economic Census, the percentage of output in the goods-related sectors of the economy was nearly three-fourths of the output of the entire economy in Arizona (Table 2.1). The largest goods-related sectors are wholesale trade, retail trade, and manufacturing. These three sectors combined account for over 60 percent of the State's economy in 1997. The goods-related sector accounts for 42 percent of the total employment in the State. This is a lower percentage than the contribution to economic output of the goods-related sector, which indicates that the goods-related sectors are more productive than the service sector.

Relative to the entire U.S., Arizona has a higher percentage of its economic output in the goods-related sectors, but a slightly lower percentage of its employment in goods-related sectors. Retail trade and construction are particularly higher in Arizona, compared to the U.S. These factors are consistent with Arizona's demography of being a growing state with goods being moved to support personal consumption.

Employment in the goods-related sector in Arizona is more lucrative than the service sector. The average salary of the goods-related sector is 14 percent higher than the average salary in the service sector. Of particular note are the wholesale trade, manufacturing, and mining jobs, which pay over $10,000 more per year than the average job in the service sector. Nationally, average goods-related sector salaries are slightly lower than service sector salaries.

Table 2.1 Economic Output and Employment by Sector for Arizona in 1997

Sector	Sales ($1,000)	Percent of Total – AZ	Percent of Total – U.S.	Employees – AZ	Percent of Total – AZ	Percent of Total – U.S.	Salary Per Employee – AZ
Wholesale trade	45,899,068	21.3%	22.8%	80,155	4.9%	5.7%	34,295
Retail trade	43,960,933	20.4%	13.8%	232,050	14.1%	13.8%	18,202
Manufacturing	43,030,348	20.0%	21.6%	193,616	11.8%	16.7%	34,881
Construction	19,115,244	8.9%	4.8%	131,871	8.0%	5.6%	27,460
Transportation & warehousing	4,086,230	1.9%	1.8%	45,233	2.8%	2.9%	24,479
Mining	3,068,897	1.4%	1.0%	12,889	0.8%	0.5%	39,569
All goods-related sectors	159,160,720	73.9%	65.8%	695,814	42.4%	45.2%	27,256
All services	56,120,983	26.1%	34.2%	945,281	57.6%	54.8%	24,000
All sectors	215,281,703	100.0%	100.0%	1,641,095	100.0%	100.0%	25,380

Source: U.S. Bureau of the Census, U.S. Economic Census, 1997.

2.2 Production of Goods for Domestic Market

The Bureau of Transportation Statistics (BTS) estimates the goods moved throughout the U.S. based on shipper surveys in its Commodity Flow Survey (CFS). This data allows for goods movement estimates to be created by commodity and origin-destination pairs for all goods by value and by tonnage. Table 2.2 shows the distribution of goods movement originating in Arizona by commodity, including shipments with destinations in Arizona, based on the most recent (1997) CFS data. The electronics industry is observed to be the dominant shipment type in terms of value for goods shipped in the State. The movement of goods in the electronics industry constitutes nearly one-third of the value of all the goods shipped, and it is over five times larger than the movement of the next largest commodity, base metals. The five next largest commodities constitute only 20 percent of the total in terms of value.

Table 2.2 Value of Shipments by Commodity and Tonnage for Arizona in 1997

Commodity	Value ($ mil)	Value %
Electronic and other electrical equipment and components and office equipment	27,628	32.0%
Base metal in primary or semi-finished forms and in finished basic shapes	4,744	5.5%
Miscellaneous manufactured products	4,373	5.1%
Motorized and other vehicles (including parts)	4,297	5.0%
Transportation equipment, n.e.c.	4,147	4.8%
Other prepared foodstuffs and fats and oils	3,997	4.6%
Machinery	3,810	4.4%
Chemical products and preparations, n.e.c.	2,798	3.2%
Precision instruments and apparatus	2,490	2.9%
Mixed freight	2,244	2.6%
Metallic ores and concentrates	2,075	2.4%
Other 30 commodities	23,653	27.5%
All commodities	86,256	100.0%

Source: Bureau of Transportation Statistics, Commodity Flow Survey, 1997.

2.2.1 Transportation Expenditure by Industry

The industries shipping the commodities shown in Table 2.2 consider a mix of in-house and outsourced transportation to deliver goods to their final destination in Arizona. Data from the National Transportation Satellite Account (NTSA), shown in Table 2.3, were used to develop estimates of the total amount spent on transportation for each commodity, and to identify the split between insourced and outsourced shipments. This table assumes that transportation spending for specific industries in Arizona mirrors that for the rest of the nation. The electronics industry in Arizona is estimated to spend the highest amount among all industries on transportation with $418 million. This indicates that improvements in the transportation system are likely to have the largest economic impact on the electronics industry. The percentage spent on transportation for the electronics industry is estimated to be 1.5 percent. This is one of the lowest percentages spent on transportation for any industry. Therefore, even though this industry will benefit from transportation improvements, it is not likely that the electronics industry in Arizona will gain a competitive advantage over other states due to transportation improvements.

Table 2.3 Value Spent on Transportation by Commodity Originating in Arizona in 1997 *(in Million Dollars)*

Commodity	Total Value of Shipments	Transportation Spent		Spent on Transportation	
		Outsourced	Insourced	Total	Percent
Electronic and other electrical equipment and components and office equipment	27,628	358.5	59.8	418.3	1.5%
Base metal in primary or semi-finished forms and in finished basic shapes	4,744	214.9	33.4	248.2	5.2%
Miscellaneous manufactured products	4,373	67.9	32.7	100.6	2.3%
Motorized and other vehicles (including parts)	4,297	99.7	40.7	140.4	3.3%
Transportation equipment, n.e.c.	4,147	62.2	19.2	81.4	2.0%
Other prepared foodstuffs and fats and oils	3,997	109.3	38.7	148.0	3.7%
Machinery	3,810	58.5	20.1	78.6	2.1%
Chemical products and preparations, n.e.c.	2,798	80.9	6.1	87.0	3.1%
Precision instruments and apparatus	2,490	25.4	3.8	29.2	1.2%
Mixed freight	2,244	57.9	20.9	78.8	3.6%
Metallic ores and concentrates	2,075	36.0	47.8	83.9	4.0%
Gasoline and aviation turbine fuel	1,945	70.5	8.4	78.9	4.1%
Furniture, mattresses and mattress supports, lamps, lighting fittings	1,870	42.2	47.8	90.0	4.8%
Articles of base metal	1,832	36.5	9.4	45.9	2.5%
Plastics and rubber	1,789	68.4	13.9	82.3	4.6%
Pharmaceutical products	1,682	48.6	3.7	52.3	3.1%
Textiles, leather, and articles of textiles or leather	1,657	35.9	10.0	45.9	2.8%
Alcoholic beverages	1,403	38.4	13.6	51.9	3.7%
Printed products	1,365	28.5	7.6	36.1	2.6%
Nonmetallic mineral products	1,256	81.0	19.6	100.5	8.0%
Milled grain products and preparations, and bakery products	1,062	29.0	10.3	39.3	3.7%
Wood products	971	21.9	24.8	46.7	4.8%

Table 2.3 Value Spent on Transportation by Commodity Originating in Arizona in 1997 *(in Million Dollars)* **(continued)**

Commodity	Total Value of Shipments	Transportation Spent		Spent on Transportation	
		Outsourced	Insourced	Total	Percent
Meat, fish, seafood, and their preparations	836	22.9	8.1	30.9	3.7%
Basic chemicals	673	19.4	1.5	20.9	3.1%
Pulp, newsprint, paper, and paperboard	583	12.2	3.2	15.4	2.6%
Fuel oils	578	20.9	2.5	23.4	4.1%
Animal feed and products of animal origin, n.e.c.	530	14.5	5.1	19.6	3.7%
Paper or paperboard articles	521	24.6	1.8	26.4	5.1%
Commodity unknown	283	7.3	2.6	9.9	3.6%
Coal	282	4.9	6.5	11.4	4.0%
Coal and petroleum products, n.e.c.	209	7.6	0.9	8.5	4.1%
Fertilizers	85	2.5	0.2	2.6	3.1%
Tobacco products	84	0.9	0.1	0.9	1.1%
Waste and scrap	75	2.2	0.2	2.3	3.1%
Natural sands	45	0.8	1.0	1.8	4.0%
Nonmetallic minerals n.e.c.	10	0.2	0.2	0.4	4.0%
Monumental or building stone	4	0.1	0.1	0.2	4.0%
Nonclassifiable	2,023	52.2	18.9	71.0	3.6%
All commodities	86,256	1,864.8	545.2	2,410.0	2.6%

Source: Bureau of Transportation Statistics, Commodity Flow Survey and National Transportation Satellite Account data, 1997

Commodities that are relatively high in value and that are estimated to require a relatively high percentage spent for shipments include base metals and food products. These commodities have the highest potential for price reductions and competitive advantage from improvements in the transportation system. For example, a 20 percent reduction in transportation costs for base metals would reduce the overall operating costs by one percent to produce these commodities. In low margin industries, such as mining and agriculture, these small percentage reductions can result in increased market share for Arizona businesses.

2.2.2 Goods Movement within the Electronic Industry

Table 2.4 shows the modal usage for goods movement in the electronics industry, compared to goods in other industries in Arizona. Over one-half of the goods moved in the electronics industry are shipped by parcel, United States Postal Service, or other courier. For other industries, this mode represents only 10 percent of the shipments by value. Most goods in other industries rely on the truck mode for their shipments. The truck mode carries 74 percent of the goods in other industries by value, compared to just 20 percent for the electronics industry.

Table 2.4 Mode Split for Electronic Goods Shipped in Arizona in 1997

Mode	Electronics Industry ($ Billion)	Percent of Total	Other Industries ($)	Percent of Total
Parcel, U.S. Postal Service, or courier	14.0	51%	6.1	10.4%
Air	7.5	27%	3.8	6.5%
Truck	5.6	20%	43.6	74.4%
Rail	(Not reported)	< 1%	3.5	6.0%
Other	(Not reported)	< 2%	1.6	2.7%
Total	**27.6**	**100%**	**58.6**	**100.0%**

Source: Bureau of Transportation Statistics, Commodity Flow Survey, 1997.

2.2.3 Goods Movement in Other High-Value Industries

After electronics, the next five largest commodities in terms of value moved in Arizona are base metals, miscellaneous manufactured products, motorized vehicles, other transportation equipment, and prepared foodstuffs. Table 2.5 shows the value of these goods and the mode split for each commodity. Each of the modes is important for at least one of these high-value industries. The rail mode carries over $1 billion worth of base metal originating in Arizona. The air mode carries a large percentage of the transportation equipment (likely related to parts) and precision instruments, in addition to being critical for the electronics industry. The courier mode is also important for these three industries. In addition, miscellaneous manufactured products are also reliant on couriers for a large percentage of their shipments. The truck mode is important for all of the modes. Excluding the precision instruments, the truck mode carries over $1 billion worth of goods for each of the other top 10 commodities.

Table 2.5 Mode Split for Top 10 Commodities by Value Originating in Arizona in 1997

All Commodities	Value ($ mil)	Percent of Total	Truck	Rail	Water	Air (Includes Truck & Air)	Parcel, U.S. Postal Service, or Courier	Multiple or Unknown
Electronic and other electrical equipment and components and office equipment	27,628	32%	20%	0%	0%	27%	51%	2%
Base metal in primary or semi-finished forms and in finished basic shapes	4,744	38%	60%	35%	0%	0%	0%	5%
Miscellaneous manufactured products	4,373	43%	51%	0%	0%	0%	23%	26%
Motorized and other vehicles (including parts)	4,297	48%	90%	0%	0%	0%	3%	7%
Transportation equipment, n.e.c.	4,147	52%	45%	0%	0%	29%	25%	1%
Other prepared foodstuffs and fats and oils	3,997	57%	100%	0%	0%	0%	0%	0%
Machinery	3,810	61%	79%	0%	0%	0%	8%	13%
Chemical products and preparations, n.e.c.	2,798	65%	96%	0%	0%	0%	3%	1%
Precision instruments and apparatus	2,490	68%	26%	0%	0%	38%	33%	3%
Mixed freight	2,244	70%	99%	0%	0%	0%	0%	1%
Other commodities	25,728	100%	77%	7%	0%	0%	9%	7%
All Commodities	86,256		57%	4%	0%	13%	23%	3%

Source: Bureau of Transportation Statistics, Commodity Flow Survey, 1997.

2.2.4 High-Tonnage Commodities

The high-value commodities produced in the State of Arizona are markedly different than the commodities that dominate in terms of tonnage. Table 2.6 shows the tonnages moved for the top 10 commodities in terms of value. As mentioned earlier, this includes goods originating within the State, including goods with destinations in Arizona. Some of the data are not reported in the CFS to protect the confidentiality of companies in a particular industry.

Table 2.6 Tonnage by Value of Goods Movements for Top 10 Commodities Originating in Arizona in 1997

Commodity	Value ($ mil)	Value %	Tons (000)	Tons %
Electronic and other electrical equipment and components and office equipment	27,628	32.0%	359	0.3%
Base metal in primary or semi-finished forms and in finished basic shapes	4,744	5.5%	3,090	2.5%
Miscellaneous manufactured products	4,373	5.1%	580	0.5%
Motorized and other vehicles (including parts)	4,297	5.0%	n/a	n/a
Transportation equipment, n.e.c.	4,147	4.8%	32	0.0%
Other prepared foodstuffs and fats and oils	3,997	4.6%	6,439	5.3%
Machinery	3,810	4.4%	381	0.3%
Chemical products and preparations, n.e.c.	2,798	3.2%	n/a	n/a
Precision instruments and apparatus	2,490	2.9%	27	0.0%
Mixed freight	2,244	2.6%	1,084	0.9%
Top 10 commodities	60,528	70.2%	11,992	9.9%
Other 32 commodities	25,728	29.8%	109,655	90.1%
All commodities	86,256	100.0%	121,647	100.0%

Source: Bureau of Transportation Statistics, Commodity Flow Survey, 1997.

The 10 commodities shown in Table 2.6 represent 70 percent of the total goods shipped in dollar terms, but less than 10 percent of the goods in terms of tonnage. Only three of these 10 commodities (base metal, prepared foodstuffs, and metallic ores) are over one percent of the total tonnage moved in the State.

The Federal Highway Administration (FHWA) has created the Freight Analysis Framework (FAF) database that provides goods movement data by commodity and origin-destination pair at the state level for tonnage only. Since the FAF database was collected using a different methodology compared to the BTS CFS, the two databases are not entirely consistent with one another. The FAF database also reports commodities using a different classification scheme than the CFS. Nevertheless, the FAF data are particularly useful for determining the origin-destination combination for commodities at the state level.

The top 10 commodities, in terms of tonnage moved in Arizona, are shown in Table 2.7. The data are based on the FAF database. The top four commodities represent 72 percent of the total tonnage produced in the State. Of the remaining six largest commodities in terms of tonnage, four are consistent with the top 10 dollar value of goods moved. These four commodities are primary metal products (which corresponds to base metals in the CFS data), food products (which corresponds to prepared foodstuffs in the CFS data),

chemicals or allied products (which corresponds to chemical products and preparations), and metallic ores.

Table 2.7 High-Tonnage Commodities Produced in Arizona in 1998

Standard Transportation Commodity Classification (STCC)	Internal	Outbound	All Goods Produced in State (Internal+Outbound)	Percent of Total
Clay, concrete, glass or stone products	21,901,237	1,417,614	23,318,851	19%
Petroleum or coal products	21,114,081	2,054,777	23,168,858	19%
Nonmetallic minerals	22,975,832	69,408	23,045,240	19%
Secondary flows	15,485,681	2,279,523	17,765,204	15%
Food products	2,776,080	3,924,191	6,700,271	6%
Farm products	3,822,873	2,610,167	6,433,040	5%
Lumber or wood products	1,296,378	2,567,525	3,863,903	3%
Metallic ores	2,400,116	855,156	3,255,272	3%
Chemicals or allied products	773,644	2,261,795	3,035,439	2%
Primary metal products	235,011	2,661,832	2,896,844	2%
Other 20+ commodities	3,074,613	4,932,071	8,006,683	7%
All commodities	95,855,546	25,634,059	121,489,605	100%

Source: Federal Highway Administration, Freight Analysis Framework, 1998.

Goods movement of nonmetallic mineral products and clay, concrete, glass, or stone products. Nonmetallic mineral products and clay, concrete, glass or stone products are common materials for several types of construction, including residences, commercial buildings, and roads. In large part, these activities are centered on urban areas. These products are generally mined from quarries and require little or no manufacturing (or processing) after removal from the ground. Therefore, it is beneficial to maximize utilization of the quarries that are closest to the locations of construction. These construction locations tend to be in the urban areas. In Arizona, over 99 percent of the nonmetallic minerals produced in the State remain within Arizona, while 94 percent of the clay, concrete, glass, and stone products generated in the State remain in Arizona. Due to the dominance of short-distance trips, nearly all of these goods are shipped via truck.

Goods movement of petroleum or coal products. The shipments within this commodity are dominated by truck movements from distribution centers to gasoline stations. Most of the gasoline is brought into the State via pipeline to distribution centers. Trucks are then used to deliver the gasoline to their final destination for consumption. Therefore, the vast majority of the truck portion of this goods movement remains within Arizona.

Goods movement of metallic ores and primary metals. Metallic ores are mined in several locations, primarily in the northern portion of Arizona. As shown previously in Table 2.7, the majority of the metallic ores are shipped to destinations within the State. However, Table 2.8 shows that 92 percent of the primary metal products are shipped outside of Arizona. These data indicate that metallic ores are being shipped to processing facilities inside the State, and then transformed into primary metal products for shipping outside of the State. Three states (Texas, Illinois, and California) are responsible for over 60 percent of the total shipments of primary metal products. Trucks are the largest mode for moving these outbound shipments, but rail is also quite high at around 40 percent of the mode share for Texas, Illinois, and California.

Table 2.8 Destination of Primary Metal Products Produced in Arizona in 1998

State	Tons Shipped	Percent of Total	Truck-Rail Mode Split		
			Truck Percent	Rail Percent	All Modes
Texas	767,774	26.5%	61%	39%	100%
Illinois	560,342	19.3%	60%	40%	100%
California	507,548	17.5%	78%	22%	100%
Arizona	235,011	8.1%	95%	5%	100%
Connecticut	139,849	4.8%	59%	41%	100%
Indiana	98,548	3.4%	72%	28%	100%
Mississippi	94,950	3.3%	74%	26%	100%
Michigan	94,158	3.3%	100%	0%	100%
Other States	398,663	13.8%			
Total	**2,896,843**	**100.0%**			

Source: Federal Highway Administration, Freight Analysis Framework, 1998.

Goods movement of farm products and prepared foodstuffs. Farm products represent goods shipped directly from farms, while food products are the result of farm products that are processed at manufacturing facilities. These represent the largest commodities produced in Arizona that have a relatively even balance between goods that are shipped internally and goods that are shipped outbound to other states. As shown in Table 2.9, the out-of-state recipients of farm products are distributed across a wide number of states across the U.S. California and Texas are the largest recipients of these goods, but they account for only 34 percent of the total outbound shipments for farm products produced in Arizona. As shown in Table 2.10, outbound food products are much more concentrated in the southwestern portion of the U.S. Nevada, California, Utah, and New Mexico represent 85 percent of the outbound food product shipments. Due to the perishable nature of

these products, over 90 percent of farm and food products are transported by truck in Arizona, even for the longer-distance movements.

Table 2.9 Destination States for Farm Products Originating in Arizona in 1998

Destination State	Tons	Percent of Total
Arizona	3,808,037	59.3%
California	664,797	10.4%
Texas	231,453	3.6%
Illinois	193,002	3.0%
Georgia	105,141	1.6%
Florida	101,991	1.6%
Pennsylvania	98,959	1.5%
Michigan	96,796	1.5%
New York	89,210	1.4%
Other	1,028,818	16.1%
All states	**6,418,204**	**100.0%**

Source: Federal Highway Administration, Freight Analysis Framework, 1998.

Table 2.10 Destination States for Food Products Originating in Arizona in 1998

Destination State	Tons	Percent of Total
Arizona	2,776,080	41.4%
Nevada	1,541,624	23.0%
California	1,071,788	16.0%
Utah	387,453	5.8%
New Mexico	180,729	2.7%
Texas	151,335	2.3%
Illinois	150,908	2.2%
Tennessee	108,081	1.6%
Colorado	107,654	1.6%
Other	224,619	3.4%
Total	**6,700,271**	**100.0%**

Source: Federal Highway Administration, Freight Analysis Framework, 1998.

Goods movement of secondary flows. In the FAF data, a separate commodity classification was created for secondary flows. Secondary flows represent freight flows that originate in warehouses and distribution centers. These goods originate from locations that are used for storing and sorting, but not for further manufacturing. These goods may be destined for other warehouses and distribution centers, but more likely they are destined for the final consumer. The specific goods within the secondary flow commodity include any of the other commodities in the traditional STCC system, such as electronics, food products, or lumber products. It should be noted that for all commodity-specific outputs that are prepared using FAF data, the commodity detail within the secondary flows are not reported.

Because warehouses and distribution centers are often located near final consumption locations, most of the secondary flows tend to be transported by truck and remain within their state of origin. Table 2.11 shows that in Arizona, 87 percent of the secondary flows remain in the State and all of these goods are transported by truck. The vast majority of outbound flows is destined for California, Nevada, and New Mexico, indicating that Arizona serves as a regional distribution center for some freight ultimately destined to other southwestern and western states. The secondary flows to Texas are minimal, which indicates that Texas is outside the reach of Arizona's distribution activity.

Table 2.11 Outbound Destination States for Secondary Flows Originating in Arizona in 1998

Destination State	Tons	Percent of Total
California	967,726	42.5%
Nevada	598,317	26.2%
New Mexico	242,449	10.6%
Utah	196,424	8.6%
Colorado	46,770	2.1%
Illinois	22,317	1.0%
Idaho	22,275	1.0%
Texas	19,915	0.9%
Other	163,330	7.1%
Total	**2,279,523**	**100.0%**

Source: Federal Highway Administration, Freight Analysis Framework. 1998.

2.2.5 Summary of Goods Produced for Domestic Market

The electronics industry is by far the most important goods-related industry in Arizona in terms of value of goods shipped and, therefore, the most important commodity to the overall state economy. The highest tonnage goods produced in Arizona are low value commodities, such as stone, nonmetallic minerals, and petroleum products. The vast majority of these high-tonnage goods produced in Arizona remains within the State, and is consumed by industries supporting the growing population of Arizona. Of the goods shipped outside of Arizona, most are destined for other states in the west and southwest, primarily California and Texas. This interstate trade demonstrates Arizona's economic tie to nearby states.

2.3 Consumption of Goods from Domestic Market

The previous section identified the primary commodities produced in Arizona, both in terms of dollars and tonnage of output. These commodity movements were used to make inferences about the major industries in Arizona related to both economic relevance and the relative impact on freight transportation infrastructure. However, the major industries not only produce goods, but also consume goods. The consumption of these goods can be tracked by examining both inbound (shipped into Arizona from other states) and internal (within Arizona) flows. In addition to consumption by industries, there is a significant amount of consumption of goods by the local population.

This section describes the major goods shipped into the State and describes their importance to the overall economy. The CFS was used in the previous section to determine the value of shipments by commodity. However, the CFS does not include value by commodities for inbound shipments. Therefore, the analysis used to support this analysis considers the use of FAF data to characterize freight flows. The FAF data are reported in tonnages, rather than value. As mentioned previously, available data and tools were used to support this analysis. The use of other data sources, such as IMPLAN (input output economic modeling software) and Reebie TRANSEARCH data (proprietary freight data source), can be used to understand the value of goods shipped. In addition, IMPLAN also can be used to determine the types of goods and services that are purchased by industries for a region.

2.3.1 Inbound Electronics Goods Movement

As described in Section 2.2, the electronics industry is the largest goods-related industry in Arizona. The electronics industry uses a significant amount of electrical machinery as input into its manufacturing process. Therefore, tracking the inbound shipments of this commodity will reveal the level of dependence on transportation system links with other states for the electronics industry. Over 400,000 tons of electrical machinery are shipped

into Arizona – roughly equivalent to the 407,000 tons that are shipped out of the State, and much larger than the 55,000 tons that remain within Arizona. The inbound shipments of electrical machinery are a key aspect of the electronics industry in Arizona. As shown in Table 2.12, nearly one-half of the inbound shipments of electrical machinery comes from California and Texas. This is likely due to the large amount of high-tech activity in these states.

Table 2.12 Inbound Electrical Machinery Shipments into Arizona by State in 1998

State of Origin	Total Tons	Percent of Total
California	116,293	28.3%
Texas	71,343	17.4%
Tennessee	30,214	7.4%
Illinois	23,326	5.7%
Oregon	18,113	4.4%
Indiana	16,383	4.0%
Wisconsin	16,136	3.9%
Other	118,507	28.9%
Total	**410,315**	**100.0%**

Source: Federal Highway Administration, Freight Analysis Framework, 1998.

The other key inbound commodities are identified in Table 2.13. The top 10 commodities represent over 85 percent of all the inbound flows by tons into Arizona.

2.3.2 Inbound Goods Movement of Coal

Coal is the largest commodity shipped into the State constituting over 10 million of the 48 million total inbound tons. Approximately, 95 percent of the coal that is shipped into Arizona come by rail from New Mexico. Coal is used as a fuel source for power plants throughout the State.

Table 2.13 Inbound Shipments into Arizona for the Top 10 Commodities in 1998

Commodity	Tons	Percent of Total
Coal	10,653,757	22.2%
Farm Products	8,703,175	18.2%
Food and kindred products	4,728,434	9.9%
Chemicals or allied products	3,853,898	8.0%
Petroleum or coal products	2,829,623	5.9%
Lumber or wood products, excluding furniture	2,509,980	5.2%
Clay, concrete, glass, or stone products	2,336,786	4.9%
Primary metal products	2,223,921	4.6%
Transportation equipment	1,783,988	3.7%
Secondary moves	1,755,437	3.7%
Other 20 commodities	6,565,697	13.7%
Total	**47,944,696**	**100.0%**

Source: Federal Highway Administration, Freight Analysis Framework, 1998.

2.3.3 Inbound Goods Movement of Farm Products

There are approximately 8.7 million tons of farm products shipped into Arizona. This is slightly larger than the 6.4 million that are shipped out of and around the State, making Arizona a net importer of farm products. Farm products are primarily shipped into Arizona from states in the Midwest and the Plains, as shown in Table 2.14. Each of the top six states for farm product origins is in the Plains and Midwest, and these six constitute 64 percent of the total inbound shipments of agriculture to Arizona. California, with its enormous agricultural industry, ships a relatively small amount of farm products into Arizona. Roughly 91 percent of the inbound shipments of this commodity are transported by truck, with the remainder by rail. This mode-split holds true for the longer-distance shipments due to the perishable nature of farm products.

2.3.4 Inbound Goods Movement of Food Products

As shown in Table 2.15, roughly 4.7 million tons of food products are shipped into Arizona, compared to the 2.8 million tons shipped out of and 1.1 million tons shipped within the State. Arizona is a net importer of food products. California is the primary shipper of food products into Arizona; it is responsible for over one-third of the total

inbound shipments of this commodity. The other major shipper states include the Plains and Midwest states; and Texas, Utah, and New Mexico. Based on the FHWA FAF database, the rail share of food products is 20 percent, compared to 10 percent of farm products; the remaining 80 percent are carried by trucks. The higher rail share for food products is due to the decreased perishability of food products.

Table 2.14 Inbound Shipments to Arizona of Farm Products by Other States in 1998

Originating State	Tons	Percent of Total
Iowa	1,203,460	13.8%
Nebraska	1,178,039	13.5%
Minnesota	1,005,651	11.6%
Kansas	802,674	9.2%
South Dakota	706,278	8.1%
Colorado	697,819	8.0%
Utah	432,671	5.0%
North Dakota	337,135	3.9%
Texas	310,720	3.6%
Idaho	297,005	3.4%
California	291,826	3.4%
Wisconsin	269,924	3.1%
New Mexico	260,497	3.0%
Montana	208,507	2.4%
Illinois	155,631	1.8%
Other	545,338	6.2%
Total	**8,703,175**	**100.0%**

Source: Federal Highway Administration, Freight Analysis Framework, 1998.

Table 2.15 Inbound Shipments of Food Products to Arizona by Other States in 1998

Origin State	Tons	Percent of Total
California	1,565,198	33.1%
Iowa	424,394	9.0%
Texas	349,317	7.4%
Idaho	246,873	5.2%
Colorado	236,670	5.0%
Missouri	198,948	4.2%
Kansas	176,056	3.7%
Minnesota	165,033	3.5%
Utah	152,387	3.2%
Illinois	146,364	3.1%
Arkansas	138,105	2.9%
New Mexico	107,875	2.3%
Indiana	98,214	2.1%
Nebraska	79,717	1.7%
Other	643,283	13.6%
Total	**4,728,434**	**100.0%**

Source: Federal Highway Administration, Freight Analysis Framework, 1998.

2.3.5 Inbound Goods Movement of Chemicals Products

Over 3.8 million tons of chemicals are shipped into Arizona annually, as shown in Table 2.16. Five states account for nearly two-thirds of the total shipments. These five states include the petroleum rich States of Texas and Louisiana, along with Arizona's neighboring States of California and New Mexico.

Table 2.16 Inbound Shipments of Chemicals to Arizona by Other States in 1998

Origin State	Tons	Percent of Total
Texas	1,033,067	26.8%
New Mexico	513,136	13.3%
California	408,142	10.6%
Louisiana	353,832	9.2%
Oklahoma	221,059	5.7%
Other	1,324,662	34.4%
Total	**3,853,898**	**100.0%**

Source: Federal Highway Administration, Freight Analysis Framework, 1998.

2.3.6 Inbound Goods Movement of Secondary Flows

Secondary flows are movements of any type of goods from warehouses and distribution centers. These can be contrasted with primary flows which are generated at manufacturing facilities, mining sites, or farms. A large number of companies operate warehouses and distribution centers in the Los Angeles metropolitan region, and the operating range of the facilities can often stretch throughout the entire southwest region of the U.S. This explains the high percentage of inbound flows of secondary moves from California to Arizona. California is the origin state for 44 percent of the inbound shipments of secondary flows for Arizona, as shown in Table 2.17. Other nearby states, such as New Mexico, Nevada, and Utah, also have relatively high levels of shipments into Arizona.

2.3.7 Value of Inbound Goods

The 1997 CFS provides value data for inbound shipments to Arizona for all states. Table 2.18 shows that California is the largest out-of-state shipper of goods to Arizona. The value of goods shipped from California is greater than the next four greatest states combined. This indicates that the transportation infrastructure between Arizona and California is the most important interstate infrastructure in terms of Arizona's overall economy.

Table 2.17 Inbound Shipments of Secondary Flows to Arizona by Other States in 1998

Origin State	Tons	Percent of Total
California	765,923	43.6%
New Mexico	225,854	12.9%
Indiana	174,124	9.9%
Nevada	113,633	6.5%
Utah	106,339	6.1%
Texas	52,879	3.0%
Other	316,685	18.0%
Total	**1,755,437**	**100.0%**

Source: Federal Highway Administration, Freight Analysis Framework, 1998.

Table 2.18 Value of Arizona's Inbound Shipments by State of Origin in 1997

State of Origin	Value ($000)	Percent of Total
Arizona	32,386	33.6%
California	20,425	21.2%
Texas	4,387	4.6%
Illinois	2,321	2.4%
New York	2,285	2.4%
Michigan	2,118	2.2%
Other 44 states	32,440	33.6%
Total	**96,362**	**100.0%**

Source: Bureau of Transportation Statistics, Commodity Flow Survey, 1997.

■ 2.4 Directionality of Goods Movement

Arizona is a net importer of goods. Table 2.19 shows that the tons shipped into the State are nearly twice that of the tons shipped out of State. This indicates that Arizona's domestic goods movement is more focused on end consumption by the growing

population. Over one-half of Arizona's total tonnage is shipped internally within the State. The vast majority of these shipments was by truck. This underscores the importance of the state transportation system for goods movement.

Table 2.19 Tons Shipped Into and Out of Arizona in 1998

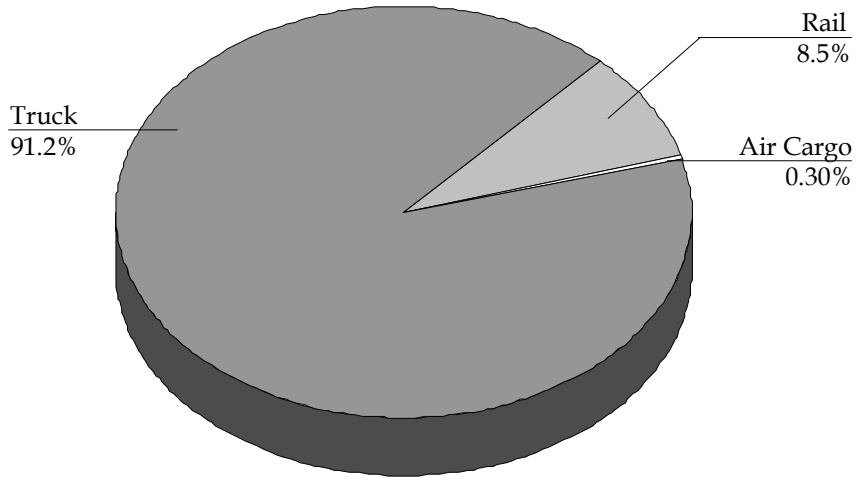
Trip Type	Tons	Percent of total
Internal	95,855,546	56.6%
Outbound	25,634,059	15.1%
Inbound	47,944,696	28.3%
Total	**169,434,301**	**100.0%**

Source: Federal Highway Administration, Freight Analysis Framework, 1998.

2.5 Goods Movement at the Metropolitan Level

In the recently completed Maricopa Association of Governments (MAG) Regional Transportation Plan (prepared in 2003) for the Phoenix metropolitan area, MAG compiled a substantial amount of data on goods movement. These data show that Maricopa County (representative of the MAG region) goods movement is tied to regions outside of the County. In 2001, only eight percent of the tonnage moved in the County were considered internal movements. In addition, 49 percent of the goods moved were shipped from outside to inside the County. Forty-three percent of the goods originated in the County, but were destined for regions outside of the County. These freight movements were dominated by the truck mode. Figure 2.1 shows that, for Maricopa County, 91.2 percent of all movements were performed by truck, 8.5 percent by rail, and the remaining 0.3 percent by air. Truck movements accounted for 86.4 percent of all inbound freight. Also, 97.8 percent of all goods that were sent out of the region were shipped using trucks. Many of these goods were likely headed to adjacent counties. According to the 1997 Commodity Flow Survey, in the greater Phoenix metropolitan region, 63 million tons of goods had both an origin and a destination in the Phoenix metropolitan region. This is roughly one-third of the combined internal, inbound, and outbound tons for the State (see Table 2.19).

Figure 2.1 Total Freight Flows Into, Out of, and Within the Maricopa County by Mode in 2001 (by Total Tons)



Source: Reebie Associates and Maricopa Association of Governments, 2001.

Approximately, 86 percent of all goods coming into the County in 2001 came from the western region of the United States. The major trading area for incoming goods into the County consisted of the remaining 14 counties within Arizona. Approximately 57 percent of all incoming freight were generated from areas within the State. When assessing trade areas throughout the U.S. in 2001, the primary trade area for Maricopa County for all incoming and outgoing freight was the State of Arizona.

Table 2.20 shows the type of truck carrier utilized to ship freight in the MAG region. In 2001, the majority (51.8 percent) of all outbound truck freight was shipped to other destinations by private truck; whereas, 47.1 percent of all truck freight consisted of for-hire Truckload (TL) movements, and only 1.1 percent consisted of for-hire Less Than Truckload (LTL) movements. Reported LTL movements, as displayed by Table 2.20, consist of individual loads that are less than 10,000 pounds.

The current Union Pacific (UP) railroad lines located in the Phoenix metropolitan area include a northern track network that extend from the southern UP main line, which is located in southern Maricopa County. The southern UP line travels east and west throughout the region and the State, and serves as a viable east-west transcontinental connection between southern California, the City of Chicago, the ports of the Gulf Coast, markets in the eastern U.S., and a number of states and cities throughout the south. The northern UP branch extends from its origin in central Pinal County, and enters into the Phoenix metropolitan area from the southeast valley. The northern UP line travels west into downtown Phoenix and terminates near the Palo Verde nuclear facility in the west valley. All northbound and southbound freight to Phoenix travels along the existing UP lines originating near Picacho Junction, which is located near the City of Eloy in central Pinal County.

Table 2.20 Truck Movements in the Maricopa County by Type of Carrier in 2001

Type of Movement	Total Tons	Percent
Outbound truck freight		
For-Hire Truckload (TL)	22,348,463	47.1
For-Hire Less Than Truckload (LTL)	524,236	1.1
Private truck	24,620,516	51.8
Total	**47,493,215**	**100.0**
Inbound truck freight		
For-Hire Truckload (TL)	23,975,594	51.3
For-Hire Less Than Truckload (LTL)	1,270,448	2.7
Private truck	21,482,233	46.0
Total	**46,728,275**	**100.0**

Source: Reebie Associates and Maricopa Association of Governments, 2001.

In 2001, 88.2 percent (7.1 million tons) of rail cargo was inbound, and 11.8 percent (954,067) were outbound from the Phoenix metropolitan area. When assessing the types of movements that occur in the rail industry, most goods are either categorized as transported by carload or intermodal rail. Unlike other areas of the U.S. where intermodal rail freight can be transferred by truck, pipeline, air, or water, within Maricopa County, the only connecting mode with intermodal rail freight is by truck. Table 2.21 shows the distribution of rail freight by type of transport – carload or intermodal. The majority of both inbound and outbound rail freight is made via carload.

Table 2.21 Rail Movements in Maricopa County by Type in 2001

Type of Movement	Total Tons	Percent
Outbound rail freight		
Carload	606,301	63.6
Intermodal	347,766	36.4
Total	**954,067**	**100.0**
Inbound rail freight		
Carload	6,261,089	88.0
Intermodal	856,247	12.0
Total	**7,117,336**	**100.0**

Source: Reebie Associates and Maricopa Association of Governments, 2001.

As shown previously in Figure 2.1, about 0.3 percent of all cargo movement within the Maricopa County is moved by air. In absolute numbers, these translate into a total of 342,674 tons of inbound and outbound air cargo moving in and out of Maricopa County in 2001. Of this amount, 72.1 percent (247,172 tons) were inbound, and 27.9 percent (95,502 tons) were outbound from the region.

2.6 Through Trips

Through trips constitute a significant portion of the truck traffic on Arizona's state transportation system. The volume of trucks can be inferred by using various information from the FAF data. Through visual observation of the national highway network, the vast majority of trucks passing through Arizona without stopping has a trip end in California. The other trip end considers states to the east of Arizona, including primarily New Mexico, Texas, Oklahoma, Arkansas, Louisiana, Mississippi, Alabama, Tennessee, North Carolina, South Carolina, Georgia, and Florida.

These origin-destination combinations represent a minimum threshold of through trucks. There are other combinations, such as Oregon-New Mexico and California-Virginia in which some, but not all, of the trucks likely use Arizona's transportation system. Trucks from southern California to states north and east of Arizona (such as Utah and Illinois) are likely to use I-15, which cuts through the northwest corner of the State.

Rail-through trips cannot be estimated using the FAF data due to the unpredictable nature of routing for some origin-destination movements. For example, a percentage of the California-Florida rail flows likely travels through Chicago, rather than using a linear east-west route. Therefore, the estimates of through trips presented in this section are likely an underestimate of actual flows, and should be considered to be a minimum level of actual rail-through trips.

The total truck tons for the origin-destination pairs from California with other states to the east of Arizona are 40.6 million tons. As shown in Table 2.22, when the tonnage of these through trucks are added to the other directional flows (of all modes), the through trucks represent nearly one-fifth of the total tons of goods moved in Arizona. Through truck tons are comparable with the inbound tonnage of goods for all modes, and it is nearly 60 percent higher than the outbound tonnage of goods from all modes.

Through trucks travel longer distances on Arizona's transportation system than other trip types, an estimate of ton-miles was performed to better compare each trip type. A rough estimate of the average distance that a through truck travels on Arizona roads is 400 miles. This is based on the 360 miles of highway between the California and New Mexico borders on the I-8 and I-10 corridor, the 500 miles of highway between the California and New Mexico borders on I-40, and the 385 miles of highway between the California and New Mexico borders on I-10. Using a rough estimate of 400 miles, through truck ton-miles is estimated at over 16 billion ton-miles. According to the 1997 CFS, the average

distance of an internal trip in Arizona is 127 miles. The average trip for an inbound or outbound truck trip is considered one-half of the average through trip distance (200 miles) based on the east-west orientation of Phoenix and Tucson, and the large volumes of trade to states both west and east of Arizona. Using these values, the ton-miles of each trip type were estimated and shown in Table 2.23. With these rough estimates, the ton-miles of the through trucks are greater than the ton-miles of each of the other three trip types, and these represent 38 percent of the total ton-miles for Arizona.

Table 2.22 Estimated Tons Shipped by Trip Type in 1998

Trip Type	Tons	Percent of Total
Internal	95,855,546	46%
Outbound	25,634,059	12%
Inbound	47,944,696	23%
Through	40,566,117	19%
Total	**210,000,418**	**100%**

Source: Federal Highway Administration, Freight Analysis Framework, 1998; and Cambridge Systematics, 2004.

Table 2.23 Estimated Ton-Miles by Trip Type in 1998

Trip Type	Tons	Rough Estimate of Average Length of Trip in AZ	Rough Estimate of Ton-Miles	Percent of Total
Internal	95,855,546	127	12,173,654,342	28%
Outbound	25,634,059	200	5,126,811,800	12%
Inbound	47,944,696	200	9,588,939,200	22%
Through	40,566,117	400	16,226,446,800	38%
Total	**210,000,418**		**43,115,852,142**	**100%**

Source: Federal Highway Administration, Freight Analysis Framework, 1998; and Cambridge Systematics, 2004.

The through flows shown in Tables 2.22 and 2.23 are likely underestimated, because the rail mode is not included. In addition, there are some highway origin-destination pairs which use Arizona's transportation system that were not included in this through trip estimate.

2.7 Forecast of Goods Movement

2.7.1 Forecast by Trip Type

The FHWA FAF data provide forecasts for 2010 and 2020 by commodity and origin-destination pair. Overall, the tonnage shipped into, out of, and within Arizona is forecast to increase by 87 percent between 1998 and 2020. By comparison, auto vehicle miles traveled (VMT) in Arizona is forecast to increase by 83 percent between 2002 and 2025. Outbound commodity flows show the largest increase of all the trip types, but internal trips will continue to dominate the directional flow of goods for Arizona. Table 2.24 shows that the internal trips are estimated to represent 60 percent of the total tonnage in Arizona by 2020.

Table 2.24 Forecast of Tons Shipped by Trip Type in 1998 and 2020

Trip Type	Tons (1998)	Tons (2020)	Percent Growth (1998-2020)
Internal	95,855,546	213,171,075	122%
Outbound	25,634,059	59,792,719	133%
Inbound	47,944,696	84,021,716	75%
Total	**169,434,301**	**356,985,510**	**111%**

Source: Federal Highway Administration, Freight Analysis Framework, 1998.

The high percentage of internal trips will continue to fuel Arizona's reliance on the state transportation system to move goods. Tables 2.25 and 2.26 show that the air mode was forecasted to increase by 237 percent between 1998 and 2020. This is the highest growth percentage of all of the modes. The share of tonnage captured by the rail industry will increase at the slowest rate (59 percent) of each of the modes. The decrease in the share of goods using rail contributes to the increase in truck usage in the State. Any shifts of goods from truck to rail would potentially relieve congestion and other state transportation system impacts. Since outbound flows are increasing at the fastest rate, these trips are the most likely to consider potential shifts from truck to rail.

Because the aviation forecasts identified in this section are based on the FAF, they are not consistent with the aviation forecasts generated as part of the *Task 9 Demand and System Performance Technical Memorandum*. To avoid confusion of data sources, only the FAF numbers are presented in this section.

Table 2.25 Forecast by Mode and Trip Type by Annual Tons in 2020

Trip Type	Transportation Mode				Percent of Grand Total
	Highway	Rail	Air	Total	
Internal	210,329,783	2,817,439	23,853	**213,171,075**	**60%**
Outbound	51,229,104	8,065,830	497,785	**59,792,719**	**17%**
Inbound	53,108,361	30,074,157	839,198	**84,021,716**	**23%**
Total	**314,667,248**	**40,957,426**	**1,360,836**	**356,985,510**	**100%**
Percent of Grand Total	**88%**	**11%**	**< 1%**	**100%**	

Source: Federal Highway Administration, Freight Analysis Framework, 1998.

Table 2.26 Forecast Growth Rates Between 1998 and 2020 by Mode and Trip Type

Trip Type	Mode			Total
	Highway	Rail	Air	
Internal	55%	38%	75%	**122%**
Outbound	145%	77%	267%	**133%**
Inbound	88%	54%	221%	**75%**
Total	**120%**	**59%**	**237%**	**111%**

Source: Federal Highway Administration, Freight Analysis Framework, 1998.

2.7.2 Forecast by Commodity Type

Four commodities represent 85 percent of the internal tons of goods moved in Arizona, including:

1. Nonmetallic materials;
2. Clay, concrete, glass or stone products; and
3. Petroleum or coal products; and
4. Secondary flows.

These commodities are growing slightly faster than Arizona's overall internal tonnage. However, two of these commodities (clay, concrete, glass, or stone products; and

secondary flows) are forecast to nearly triple between 1998 and 2020. The growth in these commodities is a result of the goods shipped to support the growing population in the State. Clay, concrete, glass, or stone products are important for commercial and industrial construction; and secondary flows consider movements from distribution centers and warehouses, which are ultimately destined for final consumption by the general population.

Secondary flows are also forecast to triple for outbound flows, making it the fastest growing outbound commodity for Arizona. As shown in Table 2.27, secondary flows are forecast to be the second largest outbound commodity by 2020, increasing from fifth largest in 1998. Arizona's position as a regional distribution center is going to be a significant driver in the increase of freight flows for the State. The vast majority of these flows is destined for California and Nevada. Specifically, the Los Angeles and Las Vegas metropolitan areas will be the most likely recipients of goods from distribution centers and warehouses in Arizona. The outbound flows of food products and primary metal products are forecasted to grow at moderate rates between 1998 and 2020, as shown in Table 2.28. These industries are likely to decrease in importance for Arizona relative to transportation and distribution.

Table 2.27 Forecast of Tons by Commodity for Internal Trips in 1998 and 2020

	1998		2020		Percent Growth (1998-2020)
Commodity Description	**Tons**	**Percent of Total**	**Tons**	**Percent of Total**	
Nonmetallic minerals	22,975,832	24.0%	36,796,782	17.3%	60.2%
Clay, concrete, glass or stone products	21,901,237	22.8%	61,071,455	28.6%	178.8%
Petroleum or coal products	21,114,081	22.0%	40,034,346	18.8%	89.6%
Secondary flows	15,485,681	16.2%	47,850,354	22.4%	209.0%
Other commodities	14,378,715	15.0%	27,418,138	12.9%	90.69%
Total	**95,855,546**	**100.0%**	**213,171,075**	**100.0%**	**122.4%**

Source: Federal Highway Administration, Freight Analysis Framework, 1998.

Table 2.28 Forecast of Tons by Commodity for Outbound Trips in 1998 and 2020

Commodity Description	1998 Tons	1998 Percent of Total	2020 Tons	2020 Percent of Total	Percent Growth (1998-2020)
Food and kindred products	3,924,191	15.3%	9,736,661	**16.3%**	**148.1%**
Primary metal products	2,661,832	10.4%	4,053,823	**6.8%**	**52.3%**
Farm products	2,610,167	10.2%	2,841,202	**4.8%**	**8.9%**
Lumber or wood products, excluding furniture	2,567,525	10.0%	5,863,216	**9.8%**	**128.4%**
Secondary moves	2,279,523	8.9%	7,387,288	**12.4%**	**224.1%**
Chemicals or allied products	2,261,795	8.8%	5,682,176	**9.5%**	**151.2%**
Petroleum or coal products	2,054,777	8.0%	5,688,847	**9.5%**	**176.9%**
Other commodities	7,274,249	28.4%	18,539,507	**31.0%**	**154.9%**
Total	**25,634,059**	**100.0%**	**59,792,719**	**100.0%**	**133.3%**

Source: Federal Highway Administration, Freight Analysis Framework, 1998

Overall, inbound tons are forecasted to increase by 75 percent. However, inbound flows of the top two commodities (coal and farm products) are forecasted to grow at much slower rates. Table 2.29 shows that food products and chemical products are forecasted to more than double between 1998 and 2020. The slow growth of coal imports is indicative of shifts in the reliance on coal as a fuel source. The slow growth of this commodity also contributes to the slower growth rate of rail to move goods by 2020. Approximately 95 percent of the coal shipped into the State were brought in by rail from New Mexico.

These data also indicate a shift in the agricultural industry, in that farm products are increasing at a very slow rate, while food products are increasing at a much faster rate. This pattern was also evident for outbound and internal flows. By 2020, agricultural products are more likely to be processed on-site or nearby to the farms where they are produced. After processing, the food products are more likely to be shipped across state borders for final consumption.

Table 2.29 Forecast of Tons by Commodity for Inbound Trips in 1998 and 2020

Commodity	1998		2020		Percent Growth (1998-2020)
	Tons	Percent of Total	Tons	Percent of Total	
Coal	10,653,757	22.2%	13,407,311	**16.0%**	**25.8%**
Farm products	8,703,175	18.2%	10,279,106	**12.2%**	**18.1%**
Food and kindred products	4,728,434	9.9%	10,960,225	**13.0%**	**131.8%**
Chemicals or allied products	3,853,898	8.0%	7,787,390	**9.3%**	**102.1%**
Other commodities	20,005,432	41.7%	41,587,684	**49.5%**	**107.9%**
Total	**47,944,696**	**100.0%**	**84,021,716**	**100.0%**	**75.2%**

Source: Federal Highway Administration, Freight Analysis Framework, 1998.

Shipments of the electronics industry will be among the fastest growing industries in terms of tons. As shown previously in this section (see Table 2.2), the electronics industry represented 32 percent of all shipments in the State by value. In terms of tons, the electronics industry is forecasted to grow by 271 percent between 1998 and 2020, compared to 87 percent for all Arizona goods. Therefore, the disproportionately higher increase in the electronics industry will result in this industry further increasing its share of the total value of all shipments for the State. Use of parcel services will continue to be the most important mode for the electronics industry. However, air and truck will be critical as well. Because the electronics industry will be an increasing part of the goods-related economy in Arizona, the needs of the electronics industry should be considered an important element of transportation planning conducted by ADOT and regional agencies across the State.

3.0 Goods Movement and the International Economy

3.0 Goods Movement and the International Economy

3.1 Exports

In 2002, $11.9 billion of exports were shipped out of Arizona (Table 3.1). This is a significant percentage relative to the total $86 billion of domestic goods that were shipped originating in Arizona in 1997. Mexico is the largest single export country for Arizona. Mexico received $3.0 billion of goods from Arizona in 2002, 26 percent of the total exports from Arizona in terms of value. However, the shipments to Asian countries exceeded the value of shipments to Mexico. The top nine export destination countries in Asia received $3.9 billon of goods from Arizona, while Mexico received $3.0 billion. Malaysia received $1.2 billion of goods, or 40 percent of the total for Mexico.

Table 3.1 Destinations for Arizona's Exports in 2002

Region	Exports (Millions of Dollars)	Percent of Total
Asia (top 9 countries only)	3,868.7	33%
Mexico	3,044.2	26%
Europe (top 4 countries only)	2,140.9	18%
Canada	1,167.3	10%
Total (top 15 countries)	10,221.1	86%
Other	1,649.9	14%
Arizona Total	**11,871.0**	**100%**

Source: U.S. Census Bureau, Foreign Trade Division, 2002.

Canada is the third largest recipient of Arizona exports, receiving $1.1 billion of goods in 2002. However, Arizona's exports to Europe were nearly double its exports to Canada. The large value of exports to Asia and Europe was due primarily to the size of these economies relative to the economies of Mexico and Canada. Therefore, in terms of value, the amount of exports was a function of both proximity to the state of origin and the size of the economy of the trade partner. The large value of exports to Asia and Canada underscores the importance of air cargo for the health of the Arizona economy.

Companies that have suppliers or customers overseas rely heavily on the parcel and bulk air cargo modes for shipments.

The Foreign Trade Division of the U.S. Census Bureau reports export data on the top 25 commodities at the six-digit level, defined by the Harmonized System Commodity Code (HSCC). These top 25 commodities represented 60 percent of the total exports for Arizona in 2002. Table 3.2 shows the groupings of 25 commodities into their respective two-digit HSCC categories. At the two-digit level, three of the commodities account for over one-half of the exports for the State, including:

- Electrical machinery and equipment;
- Aircraft, spacecraft, and parts; and
- Machinery, not electrical.

As shown in Table 3.2, Arizona's largest export commodity is electrical machinery and equipment, which accounts for over one-third of the total exports. This underscores the importance of the electronics industry for Arizona.

Table 3.2 Arizona Exports by Commodity in 2002

HS Code	Description	Exports ($ Millions)	Percent of Total
85	Electrical Machinery and Equipment	4,110.5	**35%**
88	Aircraft, Spacecraft and Parts	1,323.8	**11%**
84	Machinery, not Electrical	890.4	**8%**
90	Precision Parts and Accessories	239.1	**2%**
39	Plastic Products	216.9	**2%**
93	Arms and Ammunition	125.6	**1%**
52	Cotton and Fabrics	111.6	**1%**
48	Paper Products	85.0	**1%**
83	Articles of Base Metal	66.4	**1%**
Other	Other	4,701.7	**40%**
Total		**11,871.0**	**100%**

Source: U.S. Census Bureau, Foreign Trade Division, 2002.

3.1.1 Goods Movement at the Arizona-Mexico Border

Mexico is the largest single destination country for Arizona exports. The vast majority of the trade between Arizona and Mexico is transported by truck and rail. The U.S. Department of Transportation (DOT) records data on transborder surface trade at each of the border states in the U.S. Table 3.3 shows the distribution of the commodities that are exported to Mexico across the Arizona border. (Note that this table includes goods that are produced outside of the State, but are exported via Arizona.) Goods from the electronics industry represent over one-third of the transborder shipments through Arizona. Table 3.3 mirrors the export statistics shown in Table 3.1 for Arizona and shows similar values of the electronics industry for domestic shipments. Plastics, machinery, and paper products are the next three largest export commodities; combined, these commodities represent 28 percent of the total exports.

Ninety-five percent of the goods by value exported from Arizona to Mexico move by truck. However, 80 percent of the lower value goods (denoted by "other" in Table 3.3) are transported using trucks. This is consistent with overall modal usage of truck and rail. Low-value goods tend to use rail more often than high-value goods.

Table 3.3 U.S.-Mexico Surface Exports Through Arizona, 2002

Commodity Description	Export Value – All Modes ($ millions)	Percent of Total Exports	Export Value – Trucks Only ($ millions)	Percent of Commodity Hauled by Truck
Electrical machinery and equipment and parts	1,029.2	36%	1,013.7	98%
Plastics and articles	393.6	14%	391.5	99%
Machinery (non-electrical) and parts	255.0	9%	249.2	98%
Paper products	138.3	5%	129.5	94%
Precision instruments and apparatus	94.0	3%	93.7	100%
Articles of base metal	88.5	3%	87.1	98%
Aluminum and products	64.8	2%	64.7	100%
Articles of iron or steel	57.8	2%	57.0	99%
Copper and articles	53.0	2%	48.8	92%
Motorized vehicles (excluding railway vehicles)	46.8	2%	46.1	99%
Meat and edible meat offal	43.9	2%	42.8	97%
Other	566.3	20%	457.4	81%
Total	**2,831.2**	**100%**	**2,681.5**	**95%**

Source: U.S. Department of Transportation, Bureau of Transportation Statistics, Transborder Surface Freight Data, 2002.

The Federal Highway Administration's (FHWA) Freight Analysis Framework (FAF) database reports tonnage of goods moved by mode. The vast majority of international flows is destined for Mexico, and the vast majority of all exports to Mexico uses the highway. The FAF database can be used to examine the commodity distribution between Arizona and Mexico in terms of tonnage, and it can be used to examine growth rates for each commodity between Arizona and Mexico.

Several low-value commodities are the largest goods exported from Arizona to Mexico in terms of tonnage. Farm products, petroleum or coal products, and stone products constitute nearly one-half of the total export tons. In contrast, the commodities with the highest values represent relatively few of the tonnage exports. As shown in Table 3.4, electronic goods, plastics, and machinery represent 59 percent of the total exports by value, but only 12 percent by tonnage.

Table 3.4 Commodity Distribution by Highway of Export Tons Originating in Arizona, 1998 and 2020

STCC	Highway 1998 (Tons)	Percent of Total	Highway 2020 (Tons)	Growth (1998-2020)
Farm products	521,000	28%	1,206,100	131%
Petroleum or coal products	244,700	13%	844,200	245%
Clay, concrete, glass or stone products	167,100	9%	454,300	172%
Primary metal products	156,100	8%	380,500	144%
Food products	150,800	8%	335,500	122%
Rubber and plastic products	106,600	6%	250,900	135%
Pulp and paper products	106,000	6%	272,900	158%
Chemicals or allied products	80,600	4%	250,000	210%
Machinery, not electrical	74,700	4%	445,700	497%
Fabricated metal products	63,900	3%	167,200	162%
Transportation equipment	35,700	2%	159,000	346%
Electrical machinery, equipment or supplies	33,100	2%	251,400	660%
Nonmetallic minerals	27,100	1%	50,600	87%
Other	109,300	6%	327,900	200%
Total	**1,876,600**	**100%**	**5,396,100**	**188%**

Source: Federal Highway Administration, Freight Analysis Framework Database, 1998.

Several of the highest value goods are also the fastest growing export commodities in Arizona. For example, exports of electronics by highway are projected to grow from 33,000 tons in 1998 to 251,000 tons in 2020. This is a 660 percent increase overall, and a

9.7 percent annual increase. If the value of electronics goods grows in proportion to the projected tonnage growth, electronics exports will grow from $1.0 billion in 2002 to $5.4 billion in 2020. Arizona's other fast-growing commodities are also high-value goods. Between 1998 and 2020, machinery and transportation equipment are forecast to grow 497 percent and 346 percent, respectively.

3.2 Imports

As shown in Table 3.5, the commodities Arizona imports from Mexico are very different from the commodities it exports. Food and farm-related products represent 35 percent of total imports in terms of value. Nogales, the main port of entry from Mexico to Arizona, is the largest port of entry for winter vegetables in the United States. By comparison, the highest food or farm-related export to Mexico in terms of value was meat products, which represented just two percent of the total.

High-value commodities are also evident in imports, but in smaller proportions. Electronics is the second largest import category in terms of value, with 22 percent of the total import value. Machinery is the third largest, at 14 percent. Some high-value goods are manufactured in Maquiladoras in the Sonora region at the Arizona-Mexico border. The Maquiladoras are described in more detail in Section 3.3.2.

The FHWA FAF data can also be used to determine the distribution of the commodities imported from Mexico to Arizona. Farm and food products, for example, represent a higher total of the tonnage compared to the value: 60 percent of the imported goods by tonnage, compared to 35 percent in terms of value. Conversely, the electronics industry and machinery each represents six percent of the imports by tonnage, while they constitute 35 percent of the imports from Mexico in terms of value.

As shown in Table 3.6, Arizona's trade (of farm products in particular) with Mexico will grow much more quickly than Arizona's domestic trade. Between 1998 and 2020, imports carried by truck are projected to grow more than 300 percent, while exports carried by truck are projected to grow by 188 percent. Over the same period, domestic goods carried by truck are expected to grow by 120 percent. Electronics goods and machinery are projected to be the two fastest growing import commodities for Arizona (see Table 3.6). All of the top eight imported commodities are projected to at least double in tonnage from 1998 and 2020.

Table 3.5 U.S.-Mexico Surface Imports Through Arizona, 2002

Commodity Description	Import Value ($ millions)	Percent of Total
Edible vegetables	797.6	23%
Electrical machinery and equipment and parts	781.7	22%
Machinery (non-electrical)	457.7	13%
Edible fruit and nuts	199.0	6%
Copper and articles	197.9	6%
Fish and other marine products	137.1	4%
Textile articles	132.3	4%
Special classification provisions	118.0	3%
Precision instruments and apparatus	92.7	3%
Live animals	80.5	2%
Articles of apparel and clothing accessories	70.3	2%
Articles of base metal	58.7	2%
Aluminum and articles	51.2	1%
Zinc and articles	28.0	1%
Motorized vehicles (excluding railway vehicles) and parts	27.2	1%
Plastics and articles	23.1	1%
Other	223.4	6%
Total	**3,476.4**	**100%**

Source: U.S. Department of Transportation, Bureau of Transportation Statistics, Transborder Surface Freight Data, 2002.

Table 3.6 Commodity Distribution for Imports into Arizona (Highway Only), 1998 and 2020 (Tons)

Commodity	Highway 1998	Percent of Total	Highway 2020	Growth (1998-2020)
Farm products	1,369,600	55%	5,539,000	304%
Electronics	161,400	6%	1,109,500	587%
Machinery	148,000	6%	797,800	439%
Food Products	130,600	5%	667,500	411%
Primary metals	103,400	4%	365,200	253%
Stone products	101,800	4%	459,200	351%
Transportation equipment	97,900	4%	442,800	352%
Miscellaneous products of manufacturing	94,60	4%	327,100	246%
Rubber or miscellaneous plastic products	401,000	2%	144,000	251%
Other	245,300	10%	1,106,200	351%
Total	**2,493,700**	**100%**	**10,958,200**	**339%**

Source: Federal Highway Administration, Freight Analysis Framework Database, 1998.

3.3 Highway Flows at the Arizona-Mexico Border

3.3.1 Arizona-Mexico Border Crossing Points

The primary port of entry from Mexico to Arizona is through Nogales. The Nogales Port of Entry consists of the following crossings:

- Nogales I and II, located in the downtown area of Nogales near the terminus of I-19; and
- Nogales III, located on SR 189, approximately 1.5 miles west of Nogales I and II.

Nogales I has pedestrian, passenger vehicle, and rail access between Mexico and the U.S. Nogales II is a pedestrian crossing only, and is located immediately east of Nogales I. Nogales III serves commercial and passenger vehicles. Nogales III is reached via SR 189 (Mariposa Road), which interchanges with I-19 approximately 3.1 miles north of the border crossing. Mariposa Road is a two-lane facility from Nogales III to I-19. For commercial trips, Nogales III is open from Monday through Friday between 9:00 a.m. to 8:00 p.m., and Saturday from 9:00 a.m. to 6:00 p.m.

In 1996, the state DOTs for Arizona, Nevada, Utah, Idaho, and Montana, along with the Mexican province of Sonora and the Canadian province of Alberta, sponsored the CANAMEX Corridor Study to evaluate the needs for the highway system that connects Mexico to Canada through each of these states. In Arizona, the CANAMEX Corridor would operate on I-19, I-10, and U.S. 93, utilizing the new Hoover Dam Bridge. In Maricopa County, a bypass of the Phoenix-Mesa metropolitan region is planned that would route trucks on I-8, SR 85, and a yet-to-be built connector from the SR 85 and I-10 junction to U.S. 93.

According to this study, commercial daily truck traffic at the Nogales Port of Entry varied from 400 to 1,200 vehicles per day in 1999, with the heaviest traffic occurring during the winter months. A total of 14.4 million passengers and pedestrians; 255,000 commercial trucks; and 34,500 rail cars crossed the border from Mexico in 1999. The CANAMEX Corridor Study also estimated that international flows constitute 83 percent of the truck volume on I-19 between Nogales and Tucson, equating to roughly 2.7 million annual tons of international truck movement.

3.3.2 Economic Activity from Maquiladoras

A significant amount of the trade at the Arizona-Mexico border is related to the Maquiladora activity in the Sonora region of Mexico. The term Maquiladora refers to a manufacturing or processing firm that operates in Mexico to assemble component parts temporarily imported from other countries, and subsequently to export the completed product to the home country for final processing and sale. Maquiladora inputs are

divided into two categories: 1) primary materials (components and parts), and 2) packaging materials. As shown in Table 3.7, in 1997, total primary materials inputs for all of Mexico from all home countries were $34.5 billion, and total packaging material was worth more than $1.5 billion. The vast majority of the inputs was imported. The industry mix of the Maquiladoras is similar to the industry mix in Arizona. The electronics industry represents just over one-third of the destination for inputs of Maquiladoras. Other heavy manufacturing industries, such as transportation equipment and machinery, are also major industries for the Maquiladoras.

Table 3.7 Inputs for Maquiladoras, 1993 to 1997
(in Millions of Dollars)

Industry	Total Inputs 1993	Total Inputs 1997	% Change (1993-1997)	Imported Inputs 1997	Percent of Inputs That Are Imported
Electronics	5,751	13,720	139%	13,528	99%
Transportation equipment	5,516	7,779	41%	7,726	99%
Machinery and equipment	2,204	5,234	138%	5,172	99%
Apparel	1,029	3,231	214%	2,687	83%
Other manufacturing	1,350	3,121	131%	3,046	98%
Wood and metal furniture	932	1,132	21%	1,066	94%
Services	302	809	168%	767	95%
Tools	176	422	140%	414	98%
Chemical products	256	378	48%	354	93%
Toys and sporting goods	145	240	66%	227	95%
Leather and footwear	115	200	74%	198	99%
Food items	144	125	-13%	71	56%
Total	**17,920**	**36,392**	**103%**	**35,256**	**97%**

Source: *The Maquiladora Industry in the Arizona-Sonora Region: Impacts and Trends*, Arizona-Mexico Commission, 1999.

A study of the Maquiladora industry, titled *The Maquiladora Industry in the Arizona-Sonora Region: Impacts and Trends*, was produced for the Arizona-Mexico Commission in 1999. According to the study, at the end of the 1990s, the Sonoran Maquiladora industry included 326 factories, 36 industrial parks, and a workforce of 95,000. The study estimated that 24,000 direct jobs and 22,000 indirect and induced jobs were generated in Arizona from different industry sectors for exporting goods to Mexico.

In 1997, according to the Border Trade Institute, roughly 85 percent of all exported goods leaving the United States through Arizona border points of entry were destined for Sonora. Since $2.9 billion of goods were exported through Nogales that year, at least

$2.4 billion worth of goods traveled from the U.S. to Sonora through Arizona. The vast majority of these exports are goods that were produced in Arizona.

The Arizona-Mexico Commission report also included the results of a survey of 48 Maquiladoras in the Arizona-Sonora region. The survey included a question regarding the factors influencing the decision to locate a subsidiary in the Sonora region. Table 3.8 shows the results of this survey item with each potential benefit rated on a five-point scale, with 1 being "not important" and 5 being "very important." Of the 12 benefits considered, low labor costs ranked as the number one reason to locate a subsidiary in Sonora, with two-thirds of the respondents rating this factor "very important." The availability of a skilled workforce, low transportation costs, and the availability of cross-border transportation carriers ranked second, third, and fourth, respectively. Each of these three factors was considered "very important" by about one-third of the respondents. These responses suggest that the efficient operation of the state transportation system is crucial to the success of the Arizona-Sonora Maquiladora economic relationship. Conversely, the availability of third-party logistics firms was seen as not an important factor in this location decision. About 79 percent of the respondents felt that this was either "not important" or "somewhat important" in their decision.

Overall, as shown in Table 3.9, the survey respondents identified few barriers to the future success of the Maquiladoras. In particular, transportation infrastructure was not seen as a significant barrier to success for the Maquiladoras in the region. About 40 percent of the respondents felt that this was not an important factor at all, and only nine percent felt that it was very important. Border-crossing delays were seen as slightly more important by 63 percent of all respondents, indicating that this factor is between somewhat important to very important.

3.3.3 Through Trips from International Goods Movement

In terms of tonnage, through trips of international goods using the Arizona transportation system are much larger than through trips of domestic goods. As shown in Table 3.10, over six million tons of international goods travel between California and Texas alone. This is more than the sum of the total exports to Mexico from Arizona and the total imports from Mexico to Arizona, and is an underestimate of the through flows because several other international goods travel through Arizona. North-south through trips, in particular, are not captured in the California-Texas movement. Many of these goods likely utilize the El Paso border point of entry and travel between El Paso and the population centers in California. It is preferable for goods developed in central and eastern Mexico to use a Texas border crossing location, because the transportation infrastructure in the southwestern U.S. is in better condition than the transportation infrastructure in Mexico.

Table 3.8 Factors Influencing Sonoran Location Decision

Benefit	Not Important	Between Not Important and Somewhat Important	Somewhat Important	Between Somewhat and Very Important	Very Important	Mean
Low labor costs	2%	2%	9%	20%	67%	4.47
Availability of skilled workforce	0%	6%	34%	23%	36%	3.83
Low transportation costs	**2%**	**2%**	**46%**	**15%**	**35%**	**3.78**
Availability of cross-border transportation carriers	**4%**	**8%**	**30%**	**23%**	**34%**	**3.74**
Inexpensive land and/or rental costs	7%	11%	47%	18%	18%	3.29
Ease of technology transfer	11%	7%	36%	32%	14%	3.30
North American Free Trade Agreement (NAFTA) provisions	28%	5%	23%	12%	33%	3.16
Concentrated presence of other Maquiladoras	18%	7%	35%	22%	18%	3.15
Close proximity to U.S. consumer markets	20%	11%	30%	15%	24%	3.13
Close proximity of parent company	33%	6%	17%	15%	28%	3.00
Close proximity of suppliers	22%	17%	33%	15%	13%	2.80
Availability of third-party logistics firms	35%	14%	30%	12%	9%	2.47

Source: *The Maquiladora Industry in the Arizona-Sonora Region: Impacts and Trends*, Arizona-Mexico Commission, 1999.

Table 3.9 Barriers to Future Success of the Maquiladoras

Benefit	Not Important	Between Not Important and Somewhat Important	Somewhat Important	Between Somewhat and Very Important	Very Important	Mean
Availability of skilled workforce	8%	13%	35%	27%	17%	3.30
Foreign competition	13%	21%	30%	19%	17%	3.10
Border-crossing delays	**19%**	**19%**	**26%**	**26%**	**11%**	**2.90**
Government regulations	26%	19%	32%	19%	4%	2.60
U.S. competition	40%	23%	28%	13%	6%	2.40
Transportation infrastructure	**40%**	**13%**	**34%**	**4%**	**9%**	**2.30**
Mexican competition	53%	11%	26%	2%	9%	2.00
Availability of financing	63%	15%	9%	7%	7%	1.80

Source: *The Maquiladora Industry in the Arizona-Sonora Region: Impacts and Trends*, Arizona-Mexico Commission, 1999.

Table 3.10 Imports, Exports, and Selected International Through Flows in 1998

Shipment Type	Tons	Percent of Total
Exports (originating in Arizona)	1,876,577	18%
Imports (destined for Arizona)	2,493,687	24%
International through flows (CA-TX only)	6,102,462	58%
Total	**10,472,726**	**100%**

Source: Federal Highway Administration, Freight Analysis Framework Database, 1998.

The CANAMEX Corridor Study described high volumes of international trucks that use Arizona's highways. This study estimated that roughly 2.7 million truck tons of international goods use I-19 between Nogales and Tucson, as described in Section 3.3.1. This compares to roughly 7.5 million truck tons of international goods estimated on I-10 between Tucson and Phoenix. At a minimum, 4.8 million of the 7.5 million truck tons are likely from east-west traffic, rather than the north-south traffic that emanates from Nogales. The east-west traffic likely use border crossing points to the east and west of Nogales, but the only other major border crossing points are outside of the State. Therefore, these out-of-state border crossing points are responsible for trucks that ultimately use Arizona highways.

4.0 Logistics Trends

4.0 Logistics Trends

Worldwide logistics trends have created an intensely competitive global environment in which shippers, receivers, carriers, and intermediaries participate. From the myriad shifts taking place in the logistics field, several major national trends were identified, and the implications of these trends on goods movement in Arizona are described in the following section.

4.1 National Trends

This section describes seven national trends that will continue to influence the nature of goods movement in Arizona. The seven trends are:

1. Shift toward customer-based requirements;
2. Declining logistics costs relative to Gross Domestic Product (GDP);
3. Inventory reductions and Just in Time (JIT) trends;
4. Cycle time reduction;
5. Outsourcing of logistics services;
6. Globalization; and
7. Postponement and transloading.

4.1.1 Shift toward Customer-Based Requirements

A large part of the trends toward logistics functions being customer-centric is a result of deregulation. Deregulation in the U.S. has allowed companies to change their business models to be more responsive to customers through transportation, communications, utility, and financial functions. At the same time, deregulation has dramatically increased competition and forced carriers to become more responsive or lose business.

Customers for logistics services (e.g., warehouses, truck, etc.) have a very wide range of requirements and varying levels of sophistication. Several logistics options have developed in recent years to meet different customer needs. For example, in highly competitive markets with slim profit margins (e.g., retail supermarkets), participants are under intense pressure to minimize logistics costs, while maintaining competitive service levels. For goods in which profit margins are higher, but competition is still stiff (e.g., retail

computers), logistics performance is crucial, but costs are of lesser concern. For goods in which time-to-market is critical (e.g., high-fashion apparel), speed becomes foremost. For products with low values (e.g., sand and gravel), predictable delivery is more important than speed. In this case, logistics costs are driven down, but reliability must be maintained. For products that have severe implications for service failure (e.g., "shut down" loads of parts for assembly lines), no logistics cost will be spared to deliver on time.

At the margin and overall, the market is requiring improved reliability (better), shorter order cycle times (faster), and lower unit logistics costs (cheaper). Firms are willing to have less visibility of the actual conduct of the operation, and may even want to reduce management involvement in day-to-day logistics. The market recognizes that choosing among options and managing carriers are both getting more complex than can be managed in-house, and is looking to carriers and logistics management companies for outsourced support.

In practical terms, "better, faster, cheaper" translates into a set of stringent customer demands for high-quality service. To provide "better" freight transportation systems, carriers and intermediaries alike must offer national or even global reach, e-commerce capabilities, high reliability, and strong customer service. In addition, transportation systems must be reliable to the point where travel times are predictable for logistics service providers. Multiple supply chains will be needed to support different customers' characteristics.

To provide "faster" transportation, carriers must invest in new equipment, new terminals, and new operating systems. To provide "cheaper" transportation, carriers must continuously reduce expenses and compete strenuously for new business, while intermediaries attempt to exploit the cost-saving potential of shipment consolidation and increased bargaining leverage with customers and carriers.

4.1.2 Declining Logistics Costs Relative to GDP

The level of expenditures for logistics services in 2002, as reported by the Cass/ProLogis *State of Logistics Report,* was $957 billion (as revised). This was down from $1 trillion in 2001, the highest level of dollars ever reported for logistics costs; the first time over $1 trillion. As a percentage of the national GDP, logistics costs have been declining for many years, with 2002 being a new all time low of only 9.5 percent of GDP as shown in Figure 4.1. Recently, better management of inventories has been where the gains have been most substantial. As a percentage of GDP, inventories have been declining significantly as shown in Figure 4.2. However, not all sectors of industry have been contributing to the decline. In a study of selected sectors, the food industry (broadly defined to include processing, distribution, and retail) showed no gains over recent years.

Figure 4.1 Historical Spend on Transportation and Inventory from 1981 to 2001

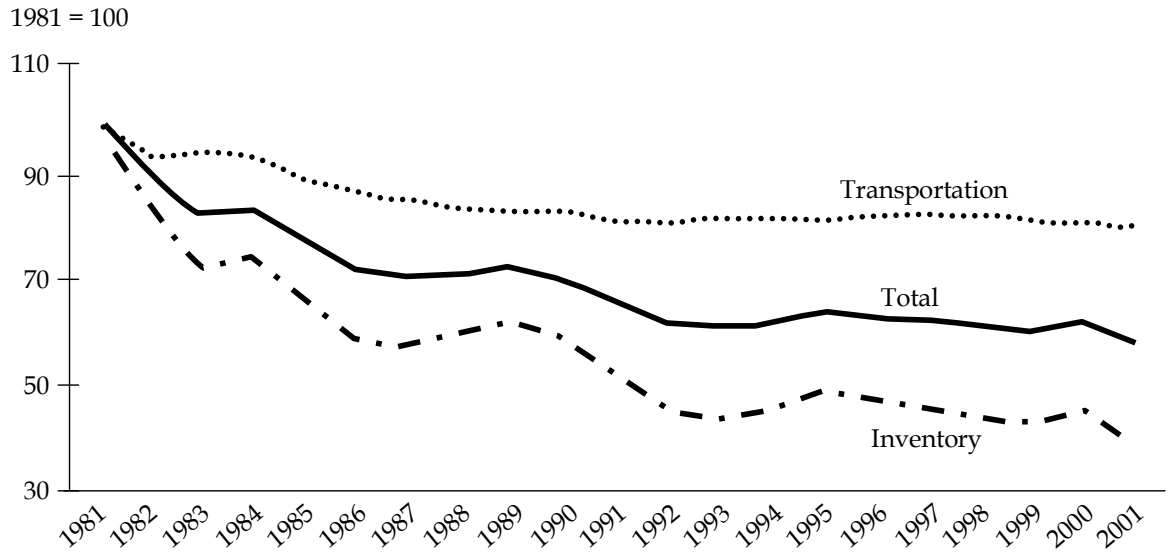
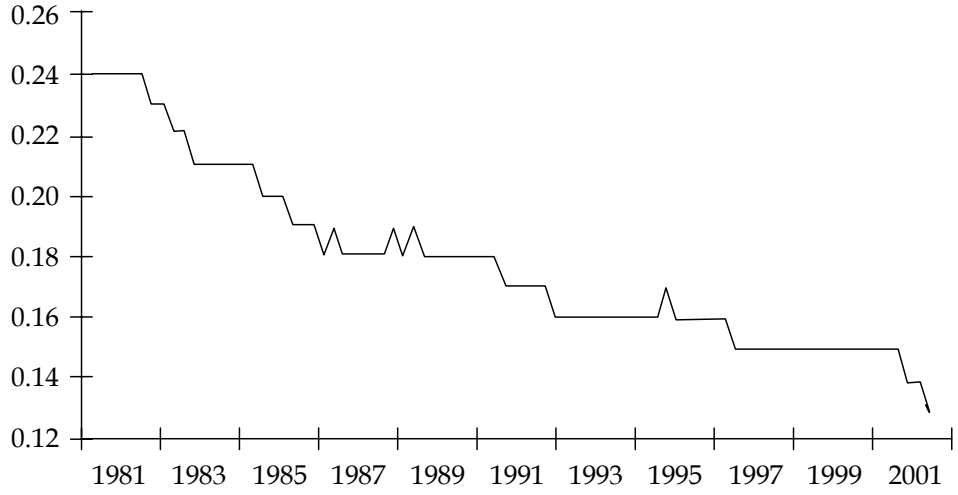


Figure 4.2 Historical Spend on Inventory as a Percent of GDP from 1981 to 2001



Source: U.S. Department of Commerce.

4.1.3 Inventory Reductions and JIT

The dollar value of inventory as a percentage of national GDP has been declining since the early 1980s. Reductions in finished goods and in-process inventory have been accomplished by precise engineering of transport modes and instant data availability. With rare

exception, stock-outs have been avoided often by moving small amounts of product via expedited services (at a transportation cost premium) to in-fill the expected shortfall. Use of such contingencies is information intensive. As a result, there has been a proliferation of computer software designed and installed to accomplish the necessary status reporting and remedial actions.

All of this augurs for smaller shipments (less than 75 to 100 pounds); moving shorter distances (in local metropolitan areas); via the fastest mode (express, dedicated truck); via the most reliable mode (one truck with its driver); with total visibility of location; timing and product at the Stock Keeping Unit level; monitoring product condition, such as temperature and level of security risk; and a proliferation of small trucks on the metropolitan roads. In turn, it augurs well for a service that can provide faster transit and greater reliability than the over-the-highway option.

JIT refers to a drastic case of inventory reduction, where inbound shipments are timed to arrive just when they are needed and on-site inventory is minimized. JIT practices have received widespread attention in the industry and popular press, but true JIT operations are relatively rare as they require intensive management and leave production vulnerable to minor outages. Tightly managed inbound logistics and low inventories, whether truly JIT or not, have important implications for truck movement in urban areas. In particular, JIT-like scheduling effectively transfers a portion of the inbound inventory to the streets. In order for a trucker to make a tight delivery appointment with near 100 percent certainty, the driver will arrive early and wait in the near vicinity of the destination. Often drivers will actually arrive in the area the night before to make sure of meeting morning appointments. Thus, a substantial portion of the inventory will be waiting in loaded trucks on nearby streets, in truck stops, or in legal or illegal off-street parking. Truckers cannot risk morning rush hour traffic, and so will typically either spend the night parked nearby or make an early morning trip from a regional truck stop.

4.1.4 Cycle Time Reduction

"Better, faster, cheaper" has come to summarize the logistics demands of major purchasers. From the carrier perspective, "faster" means reduced cycle time – in this case, the time required from product manufacturing to retail delivery. Generally speaking, faster is better, since reduced cycle time translates into lower costs of keeping inventory, faster returns on production costs, and increased responsiveness to market shifts. For all carriers and intermediaries, there has been and will be continual pressure to complete the delivery or freight handling faster, with less tolerance of delay or uncertainty. In order for the entire supply chain to yield faster cycle times, each link must be highly reliable. Ironically, one common method of achieving reliable, on-time delivery is to create "slack" in the trucker's schedule. For example, to meet narrow, early morning import delivery "windows" at locations, drayage firms must often pull import loads from marine terminals the day before and store them in a secure lot overnight.

4.1.5 Outsourcing of Logistics Services

In terms of logistics, outsourcing refers to the practice of having selected goods and/or services that were previously produced within an organization supplied from an outside company. The objective is to harness the expertise and synergy of external supply chain partners to achieve success, while sticking internally to the firm's core competencies.

Outsourcing trucking services is an increasingly common practice. In general, private trucking operations have been on the decline as fleets are sold or turned over to contract operators. Shippers and receivers are more likely to rely on a select group of "core carriers," rather than expand or maintain their own truck fleet. A collateral development is the shift of responsibility for timely pickup and delivery. Formerly, receivers of goods might have been expected to stage or store incoming loaded trailers or containers on their own property until they were ready to unload them. Now, the outside trucking firms are expected to deliver loaded trailers and containers just when desired, and to manage the storage functions off-site. This trend contributes to the demand for off-street truck parking in urban areas.

4.1.6 Globalization

Globalization describes the increasing tendency of U.S. and foreign firms to obtain inputs and sell their products worldwide, searching the globe for the best opportunities. From the perspective of inbound and outbound logistics, this trend implies increasing complexity, as domestic distribution centers draw goods from multiple foreign sources using multiple modes and carriers. Globalization has also contributed to the growth in trade, as more domestic producers are exporting their output and obtaining inputs from abroad, rather than from domestic sources. Supply lines are getting longer, and longer supply chains tend to build in buffers to cope with uneven arrival times and other fluctuations in the flow of goods. This trend towards globalization has meant that goods movement is more reliant on transportation in general, and that the reliance is spread across to all of the modes.

4.1.7 Postponement

Postponement means making decisions later in the supply to take advantage of more current information enabling increased responsiveness to market shifts. Major importers are now pursuing postponement strategies by waiting longer to decide on a mix of merchandise types and volumes for each distribution center; they can use more recent demand information and reduce subsequent rework. This trend has led some importers to shift the point in the supply chain where the final make-up of a shipment is determined.

4.2 Arizona Business Trends

Over the past few decades, Arizona has become a haven for companies looking to expand or relocate. This has been particularly true for companies with operations in California or other west coast states where labor and benefit costs are higher than in Arizona. In particular, Arizona has built an infrastructure to attract high-tech companies with focus on specific niche markets. The governors of Arizona and Sonora announced the formation of four bi-national industry clusters:

1. Manufacturing;
2. Agribusiness;
3. Health services; and
4. Tourism.

Both the manufacturing and agribusiness industry clusters are heavily reliant on freight transportation as part of their operations.

There has also been a successful recruitment enacted by the Phoenix and Tucson metropolitan areas. The Phoenix metropolitan area is home to major operations for several large goods movement-related companies, including:

- Intel;
- STMicroelectronics;
- Motorola;
- Sumitomo Sitix;
- Honeywell;
- PetsMart;
- On Semiconductor; and
- Phelps Dodge Corporation.

Phoenix features extensive telecommunications infrastructure offering companies vital bandwidth, indicating that Phoenix is likely to continue to attract high-tech companies in the future. These high-tech corporations generally produce and consume high-value, low-weight products. Therefore, the companies are likely to rely heavily on parcel delivery and air cargo in the Phoenix metropolitan area. Secondarily, having reliable truck access to the air cargo facilities in the region would be a key transportation concern for these companies.

Tucson has utilized a focused cluster approach in attracting businesses to its metropolitan region. One of its primary focus clusters is in optics technology. Optics technology is used in fiber optic telecommunications, missile guidance systems, data storage, and

medical imaging. Aerospace is also one of Tucson's largest industry clusters, anchored by companies, such as:

- Raytheon;
- Honeywell;
- Bombardier;
- Texas Instruments;
- Sargent Controls; and
- Evergreen Air Center.

Aerospace manufacturing, which has long been the staple of Tucson's economy, represents defense and space-related manufacturing, research and development, industrial high-tech fields, assembly, distribution, and warehousing. With these companies as a base, it is likely that Tucson will also continue to attract high-tech companies in the future.

4.3 Goods Movement to Support Arizona's Growing Population

As shown previously in Table 2.7, a significant percent of the tonnage shipped in Arizona support consumption by the local population. Two of the largest economic activities that support local consumption are the construction and food industries. Clay, concrete, glass, or stone products, along with nonmetallic minerals, are major inputs for the statewide construction industry. Farm products and food products are also shipped in response to local population consumption. In addition, much of the secondary flows are also food and farm products. Combined, these two industries represent nearly one-half of the total goods shipped in and around the State. Consumption of these commodities and the transportation of these commodities will continue to increase significantly as Arizona's population continues to grow.

The implications of this continued demand for population-centered freight transportation is that there will be proportionately more trucks, specially more small- and medium-duty trucks, more trucks during the working hours, and more truck distribution of consumer goods brought to the urban areas of the State by rail and truck. As that occurs, the last leg of the overall supply chain from the distribution center to either the retailer or the consumer will be pressured to perform to tighter standards. Such pressure will proportionately increase the number of truck trips on the highways and the proportion of those trips conducted by local, smaller trucks, typically two-axle, light-heavy duty trucks.

Because the cost of land is more expensive in the urban areas relative to the suburban and rural areas in Arizona, many distribution centers and some local light manufacturing goods will continue to locate further from the population centers that they are actually

serving. As that occurs, the final leg of the distribution of consumer goods will be longer in miles than previously. This means that there will be a confluence of three trends: 1) smaller shipments, 2) in smaller trucks, and 3) with truck trips being longer in miles. All three result in a greater demand for highway capacity, because no alternative mode is cost or service competitive.

4.4 Supply Chain Description for Construction and Food

This section provides details on the supply chains of the construction and food industries. These industries are both large in terms of tonnage, and are directly related to the growing population of Arizona.

4.4.1 Construction

Construction is logistics intensive. It can be viewed as occurring in three separate components:

1. Getting the manpower and equipment to the job site;
2. Getting the materials used as input to the facility to the site; and
3. Getting the fixtures and furniture into the facility to make it ready for use.

Independent of the type of structure being erected, all three components exist to a degree.

The first component can include anything from bulldozers to forms for concrete pours, from cranes to forklifts to elevators. In addition, all of these items must be removed from the job site during continuing construction, but after the use of the item is completed. This necessary step is a major added complexity as it is rare that it is either physically possible or commercially viable to simply hold the item on the site until after the project is completed. Virtually all of these support equipment and supplies are scheduled into and out of the site by truck; sometimes very large trucks, including overweight and over dimension trucks and nighttime hours of arrival and departure, particularly in city centers.

The second component is getting the materials that will go into the structure onto the site. This includes positioning the materials at the point of usage. While there can be many steps in the activity chain for any one component, the final steps are the arrival (in variably by truck) and the site, unloading, queuing into sequence, and moving to place of usage. These materials become part of the finished project as opposed to those in the first component that have to be removed from the project.

The third component sometimes is overlooked. It is the arrival and installation of everything that makes the new facility operate. Examples range from utilities to furniture, to

forklifts, to paint and signs, to whatever is permanently installed in – as opposed to built into – the facility. This includes moving in the articles that the tenant/user needs to conduct its business, be it files and computers, or racks and lighting, or traffic signals and signage, or personal effects. Often, this is the most complex logistically, because typically it is not done by the contractor, but by the landlord or facility manager, whose manager is not experienced in such activities. Some managers often outsource management of this to a contractor (of a different type, such as a moving and storage company). But, even then, the arrival of the various suppliers can be fraught with complications. While this is outside of the realm of the construction industry, it is integral to the ultimate customer's operation and satisfaction with the contractor hired to build the facility.

Other factors can significantly affect the construction of the structure and have a ripple effect on the logistics practices necessary for continuous and efficient erection of the structure. Examples of such factors are:

- **Site configuration –** A Greenfield is much easier to manage than a new multi-story office building on a lot surrounded by existing structures that must be protected.

- **Congestion and traffic conditions –** Access to an open and already improved housing development is much easier to manage than adding a lane to a bridge on a freeway.

- **Proximity of personnel and supplies –** An ability to find and access a nearby subcontractor, skilled labor, and support supplies is easier in a metropolitan area than on top of a mountain deep in a wilderness.

- **Pre-prepared components –** Assembly of custom sub-assemblies is much easier than assembly of individual pieces.

- **Transportation scheduling –** Arrival of needed parts at the pre-designated time minimizes confusion; the need to store parts at the construction site; loss and damage; inventory management; and emergency shipments of critically needed tools, parts, sub-assemblies, etc.

- **A long supply chain –** Depending on the structure, input materials can come from great distances, through multiple manufacturing and distribution intermediaries, from multiple subcontractors, through multiple intermediate handlings and shipments, and from a huge array of potential vendors (or only one vendor in the case of very specialized items).

- **The need to get the part (or support material) to the point of usage –** Almost invariably, this involved a human being transporting the piece to the point of usage, whether it be the carpenter lugging in his tools or the crane operator lifting the concrete bucket to the point of discharge.

All of these factors are involved in all three components of erecting a facility. Also, all of these factors utilize trucking to a great degree. Rare are the construction sites that are on rail or on water. Instead, usually, there is a truck trip from the source of the materials to the staging point ahead of the point of usage. So, while lumber, as an example, may be

sourced from a nearby lumberyard that obtained it via rail car or water barge, the last leg is by a truck, often trucks of multiple sizes and configurations, to bring the lumber to the point of usage. Like lumber, any of the other items that go into the final facility, be they steel beams, asphalt, fill materials, landscaping, or light fixtures, are relatively easy to isolate and understand one at a time. It is the task of sourcing each from multiple origins and manufacturers/distributors, and then sequencing them onto the building site that is the major logistical effort. To the casual observer, this may appear relatively easy, particularly when only one item is being analyzed. However, the big picture is a huge jigsaw puzzle made even more difficult by adding the fourth dimension of timing.

In addition, the use of sub-assemblies is gaining acceptance with certain types of construction. Instead of the prior practice of bringing all the pipes and fixtures to the construction site individually, now pre-assembled sets of piping attached to fixtures are more prevalent. This is due to the economic and quality assurance of having a specialized and controlled assembly line, rather than the individual assembly on the site by a carpenter, electrician, etc. Also, for many tasks, specialized contractors are employed, such as roofers, drywall, framing, etc. These practices result in many more trips to the job site by many more people and trucks than occurs with a full-time, permanent crew staffing the job. All of these practices result in specialized, medium-sized trucks making trips to and from the job site, in addition to the pickup trucks that transport the workers to and from the site.

An additional aspect of the building/road/facility construction cluster is that all of the equipment and materials used to build the facility have to be moved to and from the site and stored when they are not in use. Often, this involves additional movements to perform maintenance on or rehabilitate the items. These items move via highway trips on trucks to intermediate and final storage locations and to/from repair stations. Often, when requisitioned for a new project, they move to a nearby staging area preparatory to being sequenced into the actual construction site.

Another critical aspect is the fact that the facility being constructed is a one-time event, but the companies, suppliers, and labor are a continuing resource. While contractors, their subcontractors, and suppliers continue in business indefinitely, each construction site has its own peculiar geography and is used, in essence, only once. Hence, contractors and their subcontractors and suppliers are somewhat amorphous and ubiquitous. It is true, however, that in some ways they do coagulate. Most of the materials used to construct a facility is relatively low value and cannot tolerate high costs of transportation. Hence, suppliers tend to be located on rail and water and received product in bulk form. Contractors need yards and storage facilities. These tend to be in very low-cost locations; sometimes, they are out in the open exposed to the elements. Hence, they will be in older parts of town in otherwise abandoned lots and warehouses.

4.4.2 Food

Food processing can be disaggregated into four components:

1. Transporting farm products from the field to processing plants;
2. Processing activities at the plant;
3. Support transportation and storage; and
4. Distribution.

Each component is described in this section.

Field to processing plant. All food products originate with a harvest from the field where the item is grown or raised. Due to the ripening process, this time interval is very short and the effort is dominated by the pressure to get the raw crop gathered and moved to the first level of processing (or to retail as a fresh product). Virtually all the logistics activity is trucking of bins, tubs, or in bulk a short distance from the field to a nearby processing plant. Most agricultural products are harvested during the summer and early fall months. However, Arizona is one of the largest producers of winter crops, so the shipping patterns in the State are slightly less cyclical than other states.

Commercial trucking companies specializing in agricultural products that follow the harvest of various crops in order to maximize utilization of their trucks and drivers do much of the trucking. The trucker does not provide most of the trailing equipment, because the farmer and/or the processor need to use the trailers to hold and stage product for processing. Due to the rush to get as much done as possible in the field during daylight hours, Federal and state hours of service regulations for trucking have specific provisions allowing truck drivers engaged in agricultural hauling to be on-duty for periods of time longer than normal commercial trucking. This can result in unsafe practices, such as poorly illuminated trailers traveling after dark on rural roads and an individual driver engaging in questionable driving practices due to fatigue.

A special case of "field" to processing plant is meat. Inventory can be carried "on the hoof" for a period of time, but once the animal is slaughtered, time is critical. However, the animal is often moved live to the point of slaughter as opposed to fruit and vegetables that have to be "slaughtered" at the point they are grown.

Activities at the processing plant. This is the first point of inventory, and it is a delicate balance. On the one hand, the plant can operate at only a fixed capacity, but the crop or meat can arrive in surges. On the other hand, the plant cannot operate in excess of 24/7 when there is demand. In fact, often, it cannot operate even a second or a third shift for lack of qualified personnel. Further, the plant is idle for most of the year; thus, to have it fully operational without breakdowns for a short, intense period of processing is very taxing. The result is that fresh product can sit in the sun getting too ripe for use if the processing plant lags too far behind demand.

Once the product is initially processed, the constraint is holding capacity (i.e., vats, tanks, or other materials handling devices used at the processing plant). This, too, is a delicate balance between time and the ultimate best and highest use for the semi-processed meat, liquid, fruit, or vegetables. Ultimately, the in-process goods have to be contained or they become waste. Again, like the initial processing, the canning, bottling, and packing are constrained by plant capacity. Lacking sufficient capacity will result in product loss, but contrary-wise having insufficient demand for the processing will have adverse economic effects.

Support transportation and storage. The cyclicality of agribusiness often manifests itself in the logistics practices of the companies as practices are compromised and compete with each other. An example is the practice of making and storing of cans or bottles prior to filling them. Empty containers have to be manufactured (and stored) well in advance of usage. However, that can be extremely expensive in terms of finding and contracting for warehousing space that gets one turn per year on its inventory. Hence, some processors try to own such storage relying on historical costs to be competitive, while others tend to rent such storage resulting in space rental costs that are so high as to make uneconomic the underlying business of selling the food. This phenomenon is even more exaggerated when applied to the storage of finished or semi-finished food awaiting sale. It is even more exaggerated when the final product requires refrigeration, such as meats and frozen processed foods, due to the higher costs of refrigerated warehousing.

Another example is the need to move the semi-finished and finished product from the point of production to and from storage. Invariably, this is trucking; although some use of rail boxcar service has been used as a devise to create temporary "storage in-transit" on the railroad. There is a material cost in such handling that is forced due to space considerations and awaiting ultimate sale. As a result, some processors have engaged in private trucking and private leasing of railcars. These have been attempts to better manage the total cost of logistics and production equation. Very frequently, such as with the transport of frozen packaged meats, the company has been lured into ancillary businesses in the attempt to utilize the assets. This has proven difficult for most as it is too far removed from the core business.

Distribution. At this point, the logistics activities become dramatically more complex and competitive. Food processors sometimes sell goods at their production site; sometimes, they sell goods at the customers' site. Sometimes, they try to operate their own sales and distribution organization. All of these are intense, both in terms of marketing and logistics. The skills required for value-added distribution and food processing are very different and not often housed at the same company. There are some exceptionally successful food retail chains, often at the expense of the producer and/or the distributor. This is because there is a real battle as to extract the value out of the supply chain. This plays out in the terms of the sale, the terms of the transaction, and the details of the logistics that get the goods from processing plant to the supermarket shelf. Logistics and terms are the essence of this business, and there are as many ways of doing this portion of the business as free enterprise can generate. The core difficulty is that farmers controlling cooperative food packers are not likely to be successful competing in food distribution. Similarly, food

distribution firms have generally not been successful integrating backwards into food processing and farming.

5.0 Freight Infrastructure and Traffic Flows

5.0 Freight Infrastructure and Traffic Flows

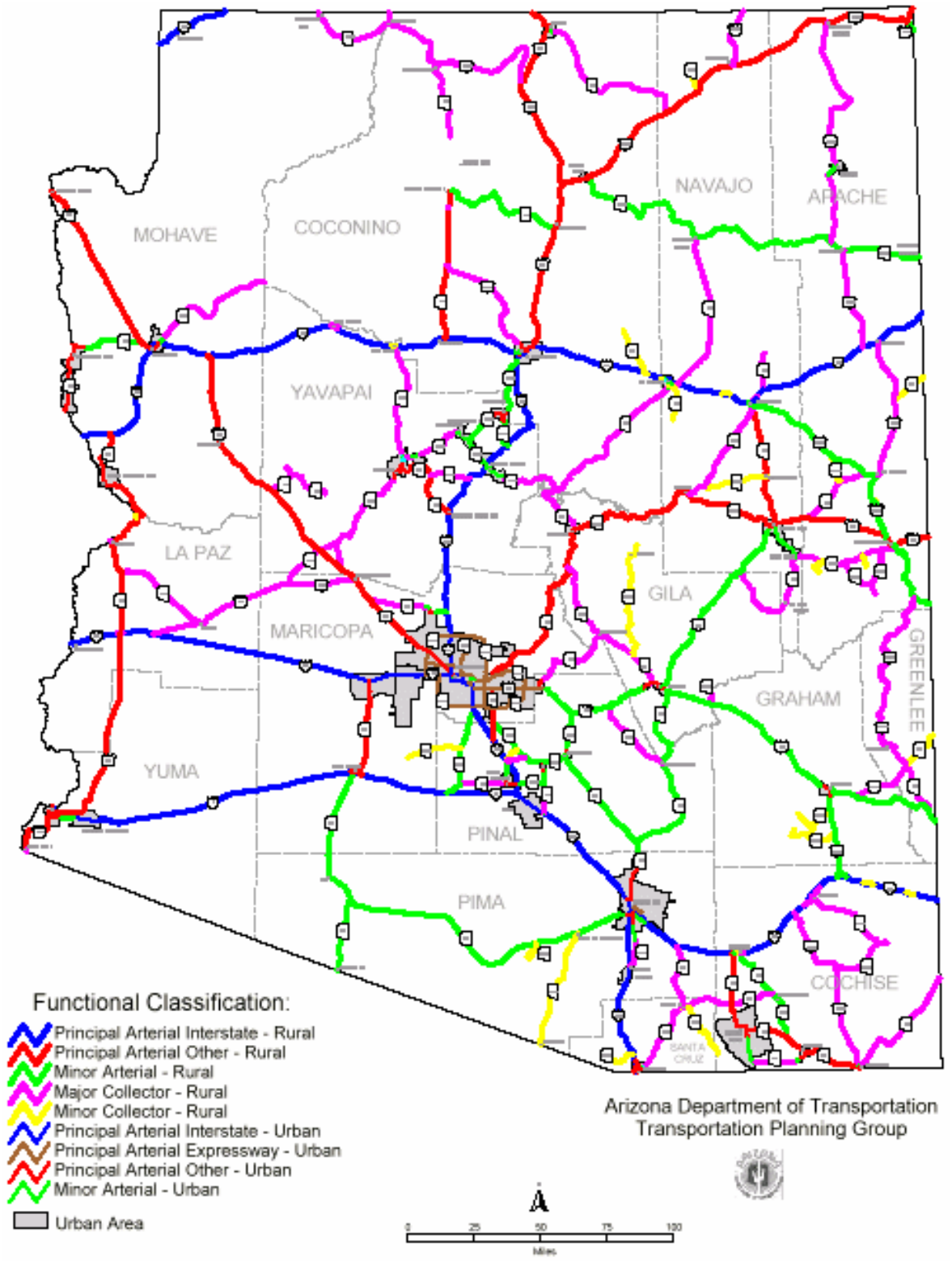
5.1 Highway Infrastructure and Flows

There are over 58,000 miles of roads in Arizona, of which two percent are interstate highways, three percent are U.S. routes, and nearly six percent are state routes. Figure 5.1 shows this extensive network by functional class. Arizona's roads are generally well-maintained; pavement ratings of "good" or "excellent" have been assigned to 79 percent of the roads owned by the Arizona Department of Transportation (ADOT), 99 percent of the interstate system, 86 percent of other freeways, and 80 percent of principal arterials.

Large trucks account for about 12 percent of the vehicle-miles traveled (VMT) in Arizona. As part of the Highway Performance Monitoring System (HPMS), ADOT counts truck at thousands of locations throughout the State. The highest truck volumes are found on the interstate system, particularly along a 100-mile stretch of Interstate 10, as shown in Table 5.1. At the 158.3 milepost on I-10 in Maricopa County, an average of 54,000 trucks passes during a typical weekday. After I-10, the next highest truck volumes are found at certain mileposts on I-40 (18,000 trucks per day); I-17 (17,000 trucks per day); and I-15 (14,000 trucks per day). The highest truck volume locations by interstate are shown in Table 5.2. The highest truck volume locations by county are shown in Table 5.3. Maricopa and Pima head the list, with an average of 54,000 trucks at the 158.3 milepost on I-10 in Maricopa County and 43,000 trucks at the 250.6 milepost on I-10 in Pima County per weekday. The location with the highest percentage of truck traffic is milepost 2.0 on I-15 in Mohave County; here, on an average weekday, 14,000 of the 22,000 vehicles recorded – 61 percent – are large trucks.

HPMS data were used to map truck volumes on Arizona's highways, as shown in Figure 5.2. The proportional thickness lines indicate that I-10 carries the largest number of trucks, although truck traffic is significant on other state highways, both urban and rural.

Figure 5.1 Major Roads in Arizona by Functional Class



Source: Arizona Department of Transportation, Transportation Division, 2001.

Table 5.1 Highest Truck Volume Locations in Arizona by Milepost, 2002

County	Inter-state	Milepost	AADT	Total Number of Trucks	Number of Single Unit Trucks	% Single Unit Trucks	Number of Combination Trucks	% Comb. Trucks
Maricopa	I-10	**158.3**	154,800	**54,200**	18,400	12%	35,800	23%
Pima	I-10	**250.6**	112,600	**42,900**	14,600	13%	28,300	25%
Pima	I-10	**251.0**	112,600	**42,900**	14,600	13%	28,300	25%
Pima	I-10	**251.4**	112,600	**42,900**	14,600	13%	28,300	25%
Maricopa	I-10	**159.3**	119,300	**41,800**	14,200	12%	27,600	23%
Maricopa	I-10	**159.5**	119,300	**41,800**	14,200	12%	27,600	23%
Maricopa	I-10	**159.8**	119,300	**41,800**	14,200	12%	27,600	23%
Pima	I-10	**253.0**	102,400	**39,000**	13,300	13%	25,700	25%
Pima	I-10	**254.3**	102,400	**39,000**	13,300	13%	25,700	25%
Pima	I-10	**251.7**	101,600	**38,700**	13,200	13%	25,500	25%

Source: Arizona Department of Transportation, Highway Performance Monitoring System, 2002.

Table 5.2 Highest Truck Volume Locations by Interstate, 2002

County	Inter-state	Milepost	AADT	Total Number of Trucks	Number of Single Unit Trucks	% Single Unit Trucks	Number of Combination Trucks	% Comb. Trucks
Maricopa	**I-10**	158.3	154,800	**54,200**	18,400	12%	35,800	23%
Coconino	**I-40**	197.9	41,600	**17,900**	6,100	15%	11,800	28%
Maricopa	**I-17**	212.0	216,500	**17,300**	5,800	3%	11,500	5%
Mohave	**I-15**	2.0	22,200	**13,500**	2,600	12%	10,900	49%
Pima	**I-19**	99.93*	75,100	**6,800**	2,300	3%	4,400	6%
Pinal	**I-8**	174.5	9,900	**3,900**	800	8%	3,200	32%

* I-19 is signed in kilometers. The value given above is a kilometerpost.

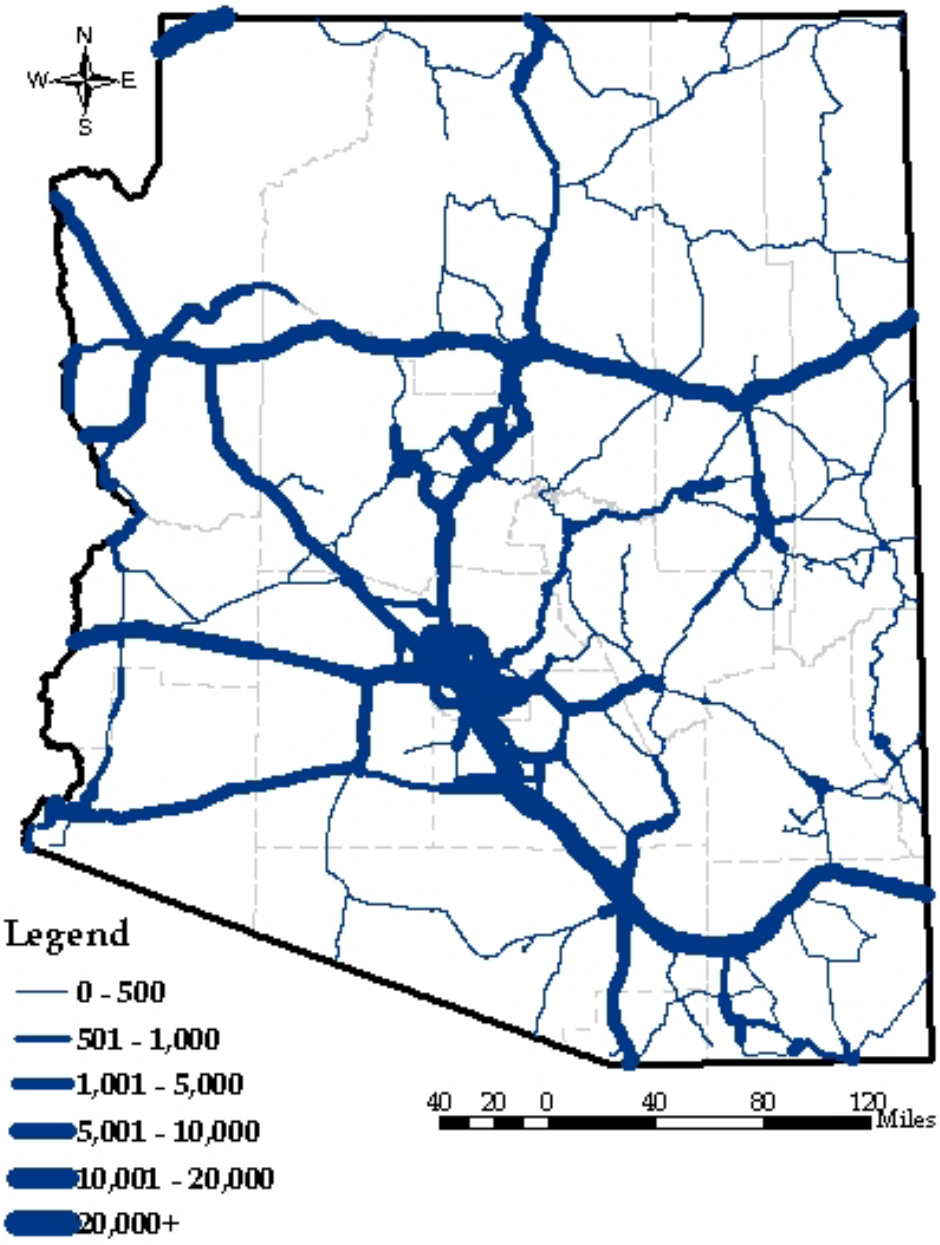
Source: Arizona Department of Transportation, Highway Performance Monitoring System, 2002.

Table 5.3 Highest Truck Volume Locations by County, 2002

County	Interstate	Milepost	AADT	Total Number of Trucks	Number of Single Unit Trucks	% Single Unit Trucks	Number of Combination Trucks	% Comb. Trucks
Maricopa	I-10	158.3	154,800	**54,200**	18,400	12%	35,800	23%
Pima	I-10	250.6	112,600	**42,900**	14,600	13%	28,300	25%
Coconino	I-40	197.9	41,600	**17,900**	6,100	15%	11,800	28%
Pinal	I-10	176.4	45,800	**15,900**	3,000	7%	12,900	28%
Mohave	I-15	2.0	22,200	**13,500**	2,600	12%	10,900	49%
Cochise	I-10	297.8	37,900	**12,000**	2,300	6%	9,700	26%
Navajo	I-40	251.7	24,200	**10,400**	3,500	15%	6,900	28%
Apache	I-40	319.6	26,600	**9,900**	1,900	7%	8,000	30%
Lapaz	I-10	45.4	22,300	**9,800**	1,900	8%	8,000	36%
Yavapai	I-17	47.6	35,300	**6,700**	1,300	4%	5,400	15%
Yuma	I-8	8.9	26,200	**3,900**	1,300	5%	2,600	10%
Santa Cruz	I-19	5.3	29,700	**3,300**	600	2%	2,600	9%

Source: Arizona Department of Transportation, Highway Performance Monitoring System, 2002.

Figure 5.2 Average Daily Truck Traffic on Arizona Highways in 2002



Source: Arizona Department of Transportation, Highway Performance Monitoring System, 2002.

Delays, caused either by unexpected events such as motor vehicle crashes or by recurring events such as rush hour congestion, can seriously disrupt the movement of freight by truck. Off-peak crashes have a disproportionately larger effect on trucks than crashes that occur at other times of day, because trucks make up a higher percentage of vehicles traveling off peak. Figure 5.3 shows the spatial relationship between truck volumes and motor vehicle crashes. Crashes occur more frequently in urbanized areas, while truck volumes are spread more evenly throughout the State. Figure 5.4 shows the spatial relationship between truck volumes and congestion. The figure indicates that trucks are most likely to suffer serious delays in Phoenix and Tucson, where congestion is greatest.

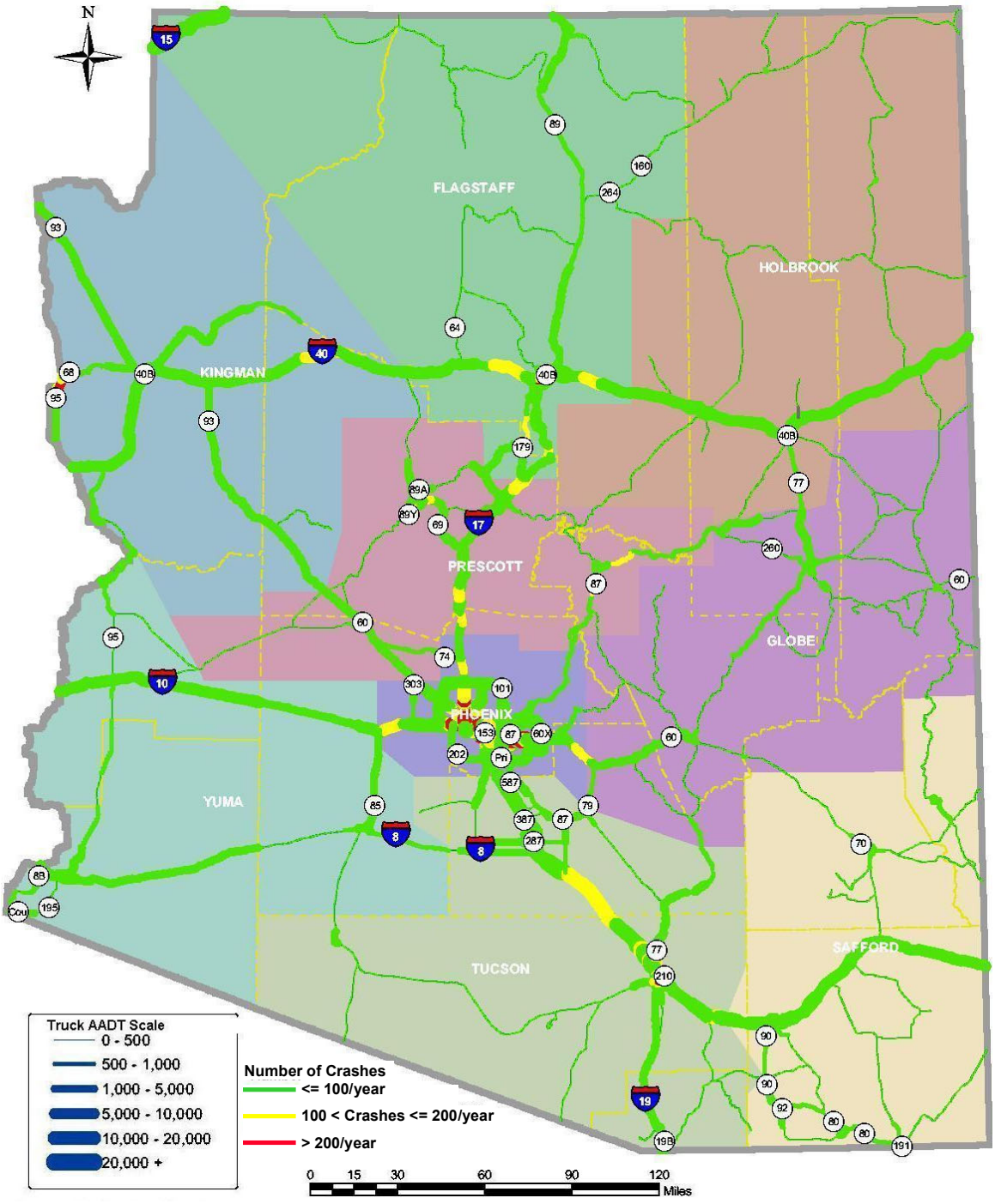
5.1.1 Highway International Ports of Entry

As shown in Figure 5.5, there are six ports of entry between Arizona and Mexico: Douglas, Naco, Nogales, Sasabe, Lukeville, and San Luis. The Port of Nogales enjoys the most convenient highway access, with Interstate Highway 19 and State Highway 82 on the Arizona side and a divided Mexican Federal Highway 15 on the Sonora side. San Luis is served by U.S. Highway 95 in Arizona and Mexican Federal Highway 2 in Sonora. Douglas is served by U.S. Highway 191, State Highway 80, and Mexican Federal Highway 2. The remaining border crossings are served only by undivided state highways. Table 5.4 shows that 348,000 trucks carrying 242,000 loaded containers of freight crossed the U.S.-Mexican border into Arizona in 1999, 74 percent of them passing through Nogales. This volume of trucks marks a 50 percent increase over Arizona-Mexico traffic reported in 1991 and 1992.

5.2 Railroad/Intermodal Infrastructure

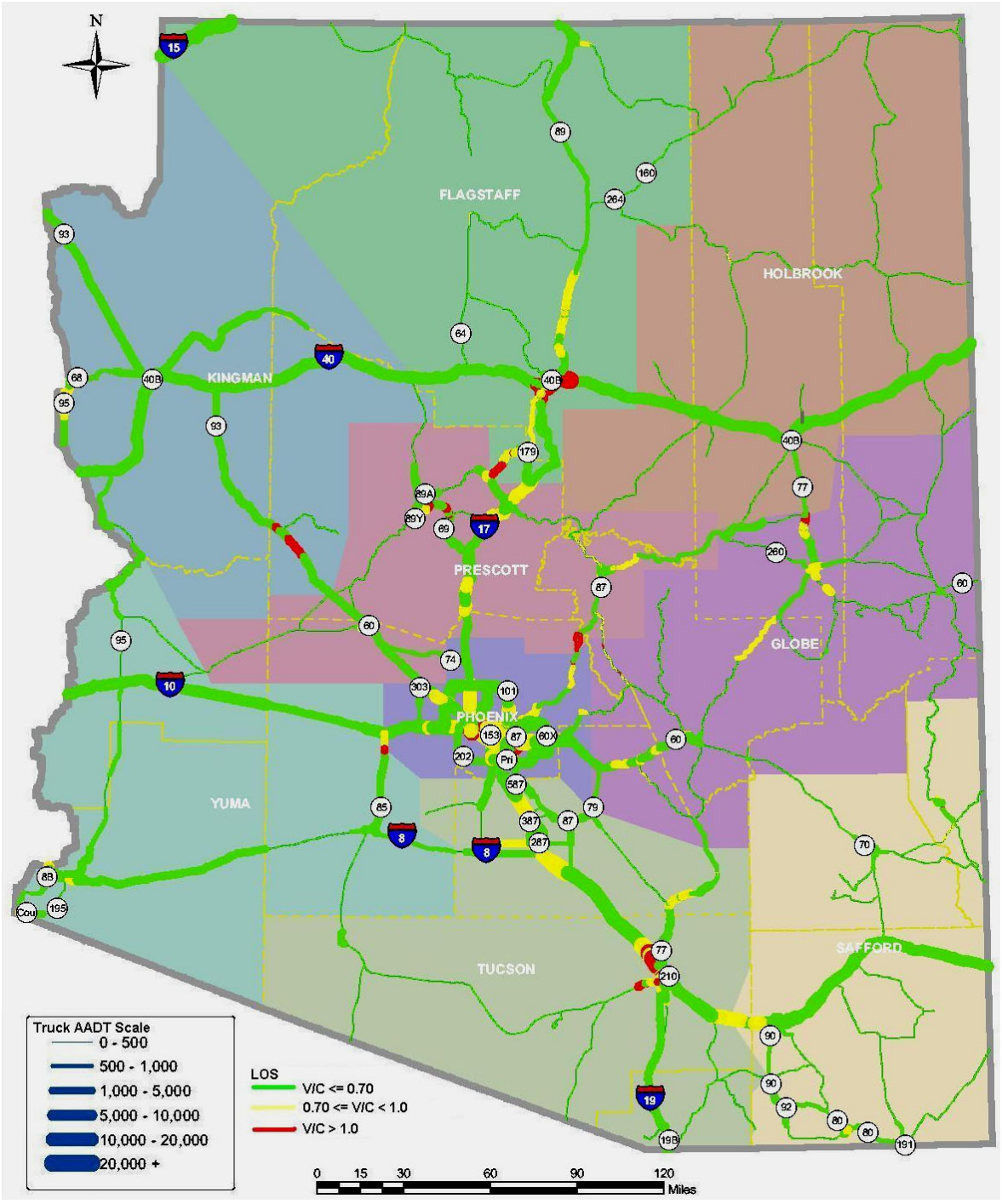
Arizona's rail network consists of 2,700 miles of track, including mainline, spurs, and yards. Of these, 1,900 actual route-miles are owned and/or operated by the railroads: 39 percent by Union Pacific (UP), 31 percent by Burlington Northern Santa Fe (BNSF), and most of remaining 30 percent by various local switching and terminal railways. A very small amount of track is operated by the U.S. Government or by private railroads for recreational purposes. All current Arizona rail lines are shown in Figure 5.6. According to the Federal Railroad Administration, there are 1,600 grade crossings in Arizona, 900 of which are public and 700 of which are private. In 2000, Arizona freight railroads employed 2,500 Arizona residents and carried 103 million tons of cargo in 4.2 million carloads.

Figure 5.3 Truck Volumes and Motor Vehicle Crashes on Arizona Highways, 2002



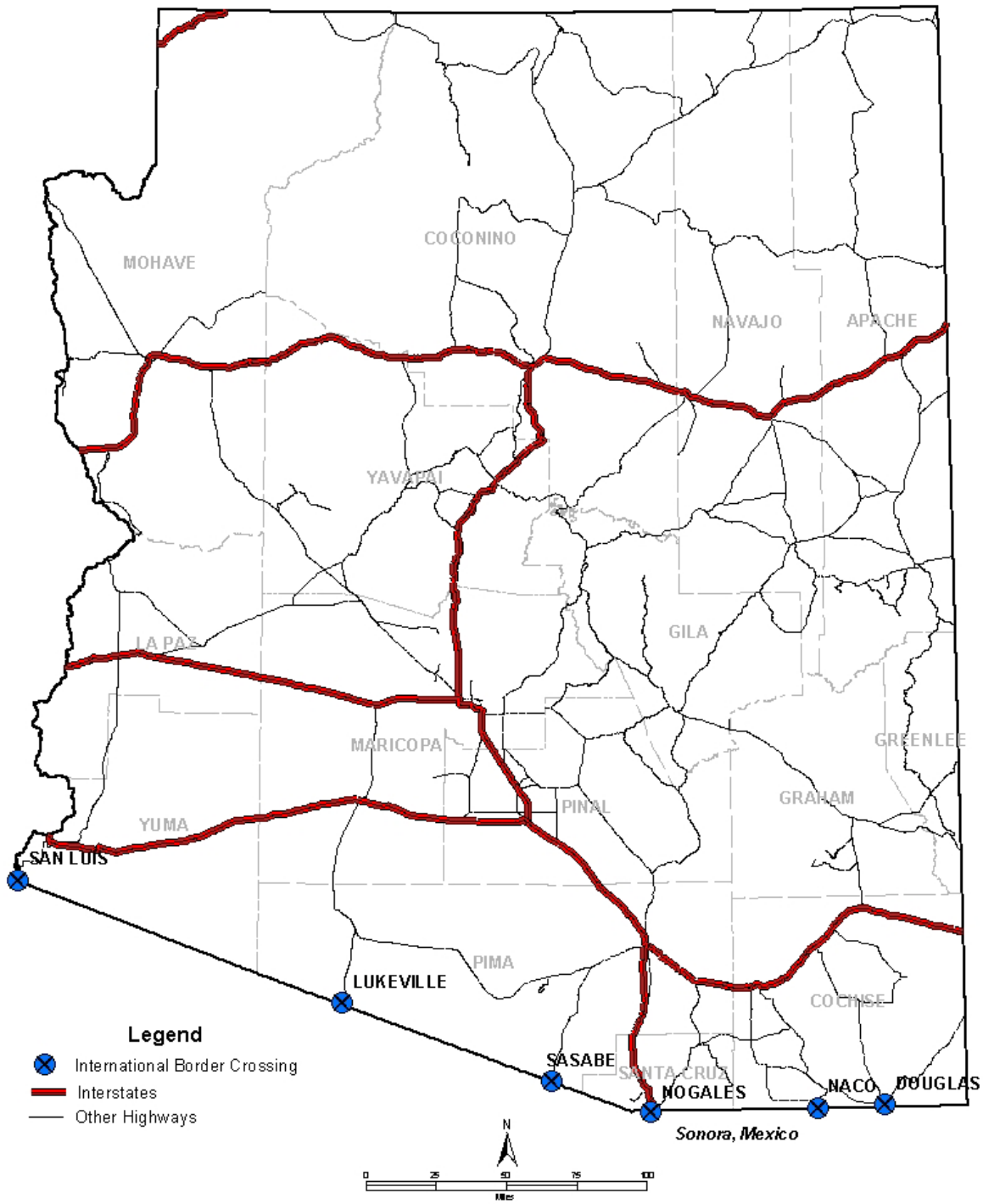
Source: Arizona Department of Transportation, Highway Performance Monitoring System, 2002; and ADOT Transportation Planning Division, 2002.

Figure 5.4 Truck Volumes and Congestion on Arizona Highways, 2002



Source: Arizona Department of Transportation, Highway Performance Monitoring System, 2002.

Figure 5.5 Arizona International Ports of Entry



Source: Arizona Department of Transportation Planning Division, 2002.

Table 5.4 Truck, Passenger Car, and Bus Volumes at Arizona-Mexico Border, 1999

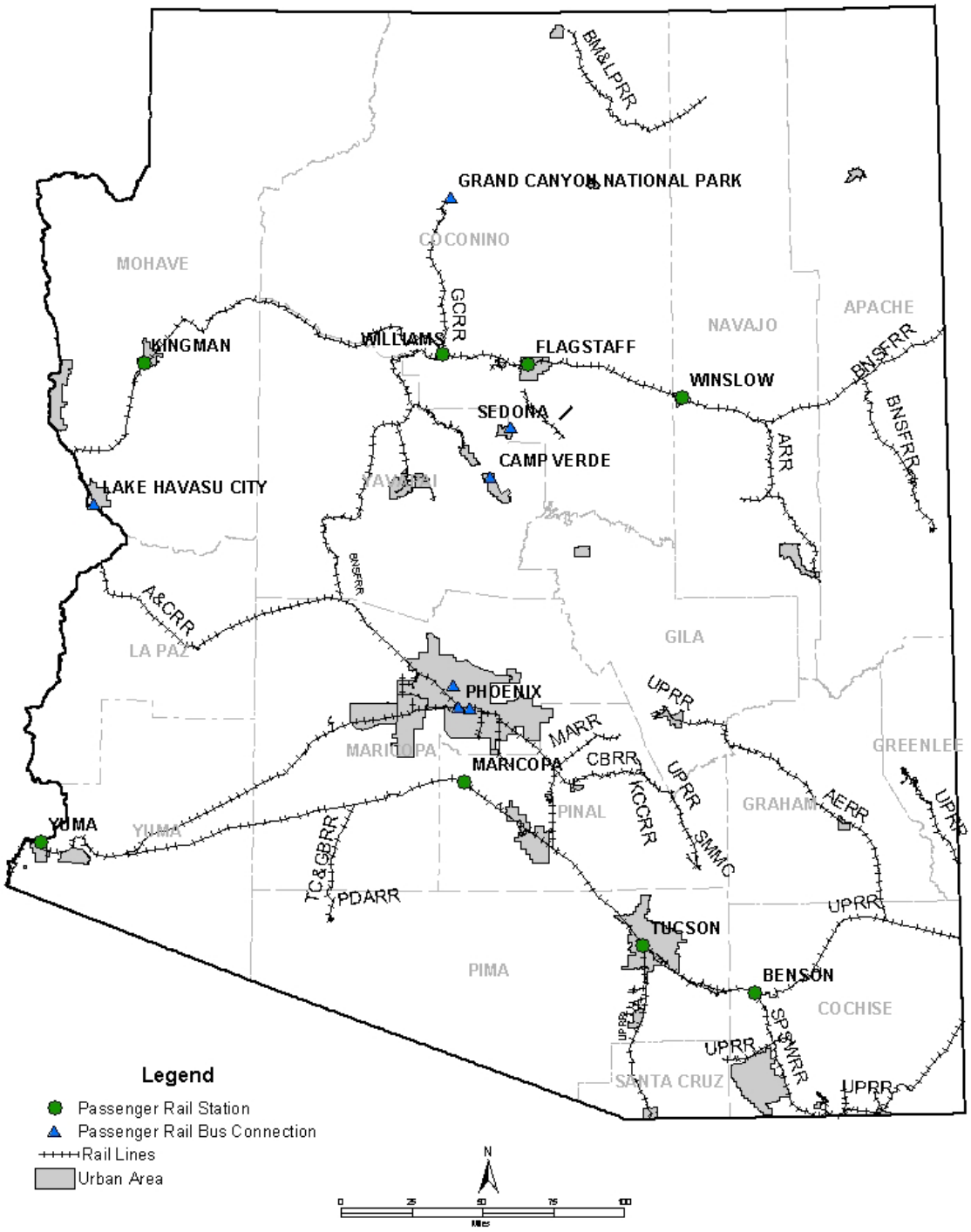
Port of Entry	Trucks	Percent of State Total	Loaded Freight Containers	Percent	Personal Vehicles Entering AZ	Percent	Buses Entering AZ
Nogales	256,426	74%	200,358	85%	4,186,962	42%	5,814
San Luis	44,829	13%	13,744	6%	2,687,387	27%	59
Douglas	32,568	9%	14,745	6%	2,150,092	22%	N/A
Naco	7,766	2%	5,886	2%	326,640	3%	N/A
Lukeville	4,291	1%	451	<1%	501,345	5%	495
Sasabe	2,442	1%	891	<1%	34,942	<1%	N/A
Total	**348,322**	**100%**	**236,075**	**100%**	**9,887,368**	**100%**	**10,018**

Source: Bureau of Transportation Statistics. Bus data not available at all border crossings.

Freight and intercity passenger rail service share the same track in Arizona. Amtrak operates three east-west through trains in states: the Southwest Chief, which provides daily service between Chicago and Los Angeles; the Sunset Limited, which provides service three times per week between Orlando and Los Angeles; and the Texas Eagle, which provides service three times per week between Chicago and Los Angeles. In Arizona, the Southwest Chief stops in Winslow, Flagstaff, Williams, and Kingman. The Sunset Limited and Texas Eagle stop in Benson, Tucson, Maricopa, and Yuma. In addition, the Grand Canyon Railway and Resort operates one round trip per day between Williams and Grand Canyon National Park. The Grand Canyon Railway serves the Amtrak station in Williams, but its schedule is not coordinated with that of Amtrak. Arizona rail lines and station locations are shown in Figure 5.6.

The Federal Railroad Administration recorded a total of 24 freight rail-related incidents in Arizona in 2003, resulting in one death, six injuries, and $4.2 million in track and equipment damage. Half of these incidents occurred in Maricopa County. Twenty-one were caused by or resulted in the derailment of a freight car or locomotive. Table 5.5 presents freight rail incident data by county, excluding rail crashes involving motor vehicles, which are reported in the FHWA crash statistics.

Figure 5.6 Arizona Railroad Lines and Passenger Stations



Source: Arizona Department of Transportation, Transportation Planning Division, 2002.

Table 5.5 Rail Incidents by County, 2003

County	Incidents	Deaths	Injuries	Reportable Damage
Cochise	2	0	0	$180,000
Coconino	2	0	0	$189,000
Gila	2	0	2	$174,000
Maricopa	12	1	4	$3,512,000
Mohave	1	0	0	$52,000
Navajo	1	0	0	$21,000
Pima	3	0	0	$37,000
Yavapai	1	0	0	$30,000

Source: Federal Railroad Administration, 2004. Excludes crashes involving motor vehicles.

5.2.1 Rail Infrastructure Between Arizona and Mexico

Important segments of Arizona's rail network serve international freight traffic between Arizona and Mexico. UP's Nogales Branch, which runs between Tucson and Nogales, parallel to I-19, connects with Grupo Ferroviaria Mexicana (GFM) at the Arizona-Mexico border. GFM operates a north-south line linking Nogales with Hermosillo, and ultimately Mexico City. As of 1998, UP handled almost 5 million gross ton-miles per mile (MGTM/M) on the line. Its shipments through Nogales include double-stack containers of auto parts bound for the Ford/Mazda assembly plant in Hermosillo, and assembled automobiles from Hermosillo bound for the U.S.

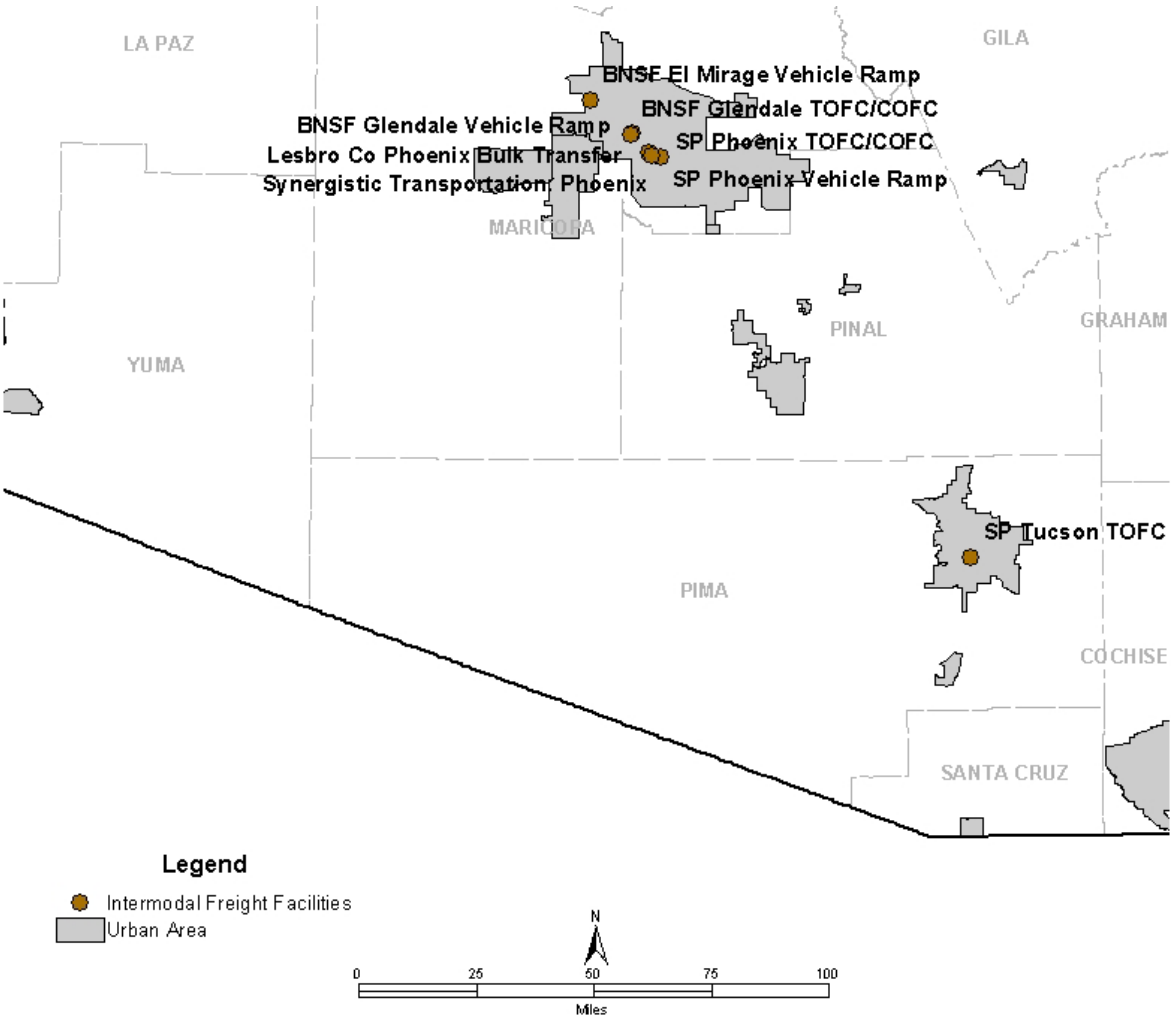
The Nogales rail border crossing is located in the City's central business district. With the volume of freight moving through Nogales projected to increase as a result of the North American Free Trade Agreement, the former Southern Pacific Transportation Company (which operated the line until its 1996 merger into the UP system) and the City of Nogales proposed moving the existing rail line outside the downtown. At present, however, there are no specific plans to act on this suggestion.

5.2.2 Intermodal Facilities

Freight intermodal facilities provide transfer points between different freight modes. There are 10 major highway-rail freight intermodal facilities in Arizona, two serving the Arizona and California Railway (ARZC), three serving Union Pacific, and five serving BNSF. Three of these facilities are container cargo facilities, three are automobile transfer points (two of which allow transfer from only rail to highway), three transfer chemicals

and chemical products, and one transfers liquid edibles. As shown in Figure 5.7, seven of the 10 facilities are located in the Phoenix metropolitan area, two are located in Parker, and one is located in Tucson.

Figure 5.7 Intermodal Facilities in Arizona



Source: Arizona Department of Transportation, Transportation Planning Division.

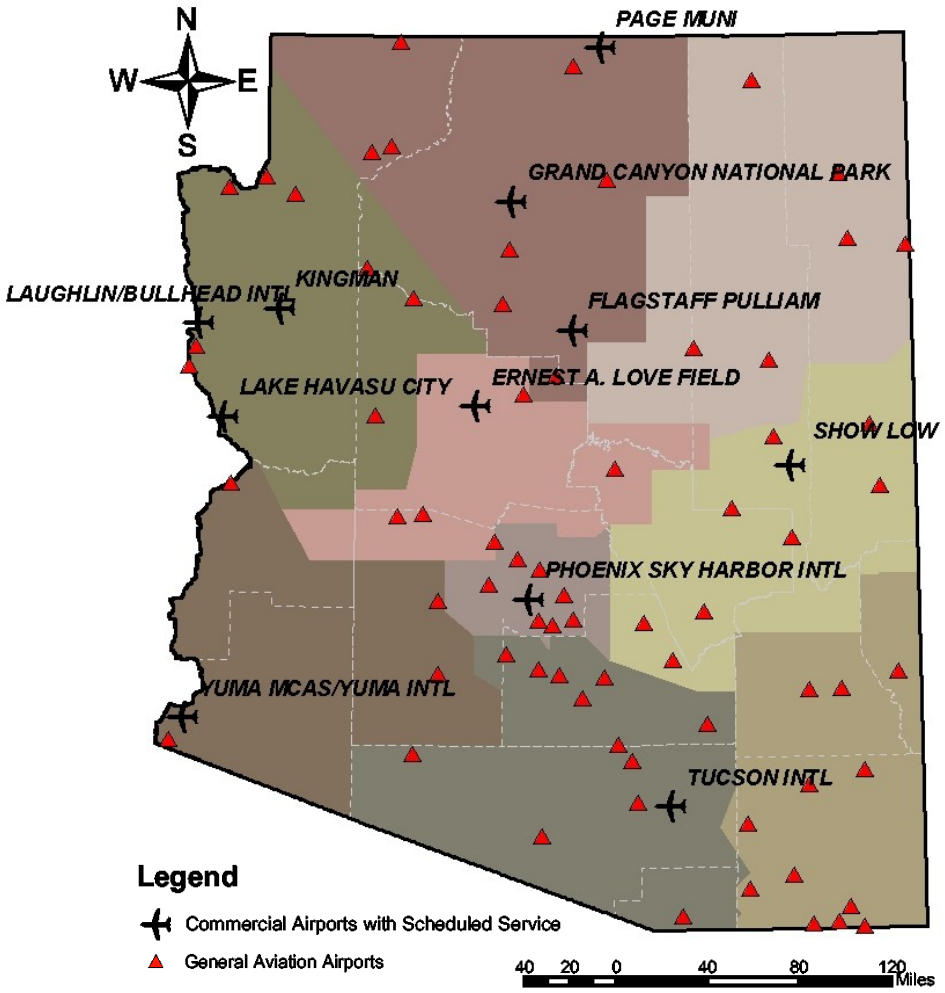
5.3 Air Infrastructure

A total of 83 airports in Arizona are classified as "public use"; that is, they may be used by the public without prior permission and without restriction within the physical capabilities of the facility. Another 236 airports are "private use," and accommodate airplanes, gliders, helicopters, and other forms of aviation. Of the 83 public-use airports, 65 are publicly owned, one is owned by the U.S. Army, one is owned by the U.S. Navy, and the remainder are privately owned. Eleven are certified to handle scheduled air carrier service; although just two, Phoenix Sky Harbor International Airport and Tucson International Airport, are the primary facilities used to transport air cargo in Arizona. The locations of Arizona's major public-use airports are shown in Figure 5.8. The year 2000 cargo and passenger enplanements for the major airports in the State are shown in Table 5.6.

Sky Harbor International is the largest airport in the Phoenix/Mesa metropolitan area that maintains active schedules for inbound and outbound air freight. Sky Harbor's air cargo facilities on the west side of the airport provide non-integrated and integrated air cargo services. Cargo Buildings A, B, and C contain a total of 198,000 square feet of space, and collectively have a total of 103 air cargo bays. Measured in tons, over 85 percent of all air cargo in Arizona move through Sky Harbor.

Air cargo operations at Williams Gateway include specialized services and unscheduled charter flights. To meet the growing demands of the east valley of metropolitan Phoenix and to relive pressure at Sky Harbor, cargo service improvements are planned at Williams Gateway. These include dedicated air cargo facilities at the east and west sides of the airport and a runway extension to accommodate air cargo aircraft. Currently, an $11 million cargo ramp is under construction and land adjacent to the ramp is being leased for new cargo-related buildings.

Figure 5.8 Locations of Arizona's Public Use Airports



Source: Arizona Transportation Planning Division, 2002.

Table 5.6 Cargo and Passenger Volumes at Arizona Airports for 2000

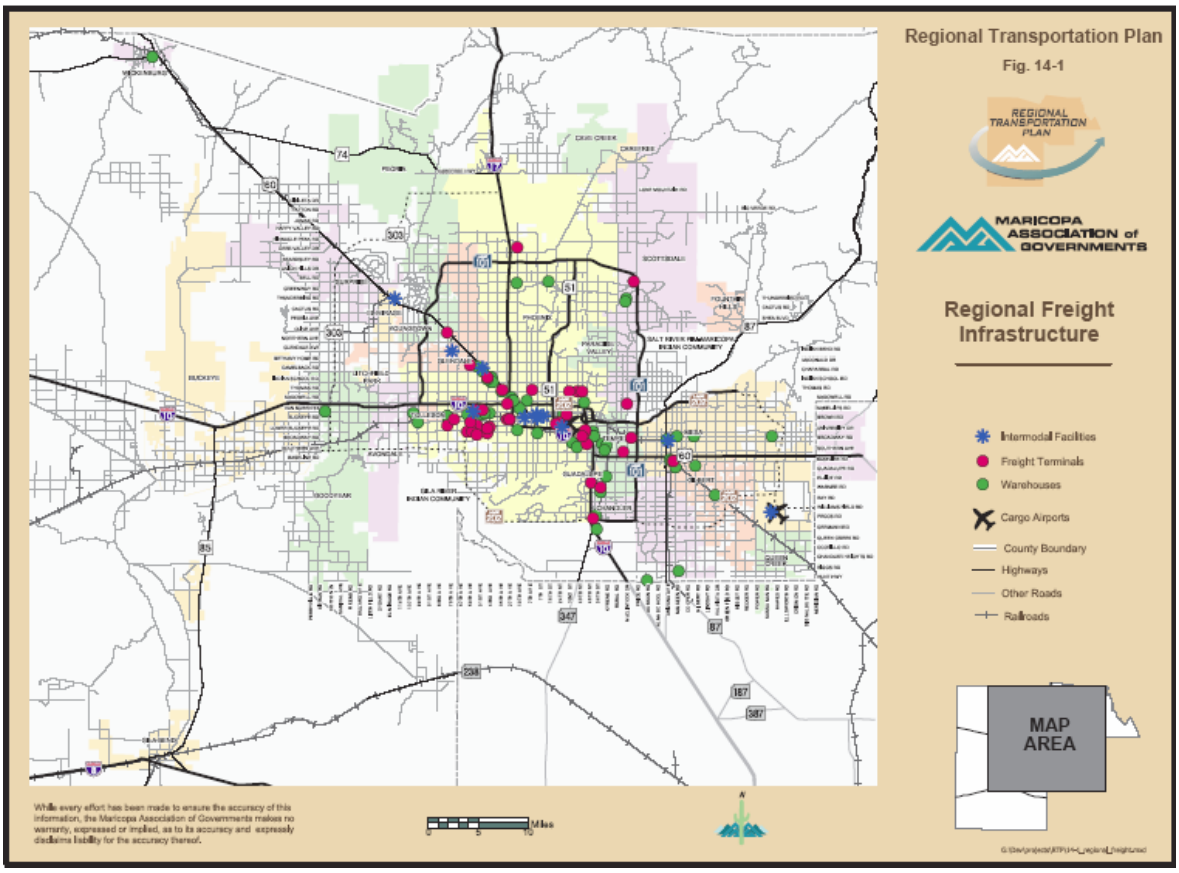
Airport	City	Cargo Gross Landed Weight (Tons)	Enplanements (Passengers)
Phoenix Sky Harbor Intl	Phoenix	374,164	17,616,143
Tucson Intl	Tucson	34,158	1,816,412
Grand Canyon National Park	Grand Canyon	–	411,416
Yuma MCAS/Yuma Intl	Yuma	–	50,337
Laughlin/Bullhead Intl	Bullhead City	–	75,020
Flagstaff Pulliam	Flagstaff	–	33,371
Page Muni	Page	–	2,131
Lake Havasu City	Lake Havasu City	–	8,569
RRA Sierra Vista Muni-Libby AAF	Fort Huachuca SIE	–	6,073
Ernest A. Love Field	Prescott	–	4,682
Show Low Muni	Show Low	–	2,857
Kingman	Kingman	–	1,656
Total		**408,322**	**20,028,667**

Source: Arizona Department of Transportation, Tucson International Airport, and Maricopa Association of Governments.

5.4 Metropolitan Freight Infrastructure

The Maricopa Association of Governments has worked extensively to document the freight infrastructure in the Phoenix metropolitan area, including freight terminals and warehouses. Figure 5.9 shows the key elements of this infrastructure. The figure shows that the majority of the freight-related facilities are located along the I-10 corridor, with another concentration of facilities along State Highway 60 northwest and east of downtown.

Figure 5.9 Phoenix Region Freight Infrastructure



Source: Maricopa Association of Governments Regional Transportation Plan (2003).

5.5 Key Freight Indicators

Several indicators can be used to measure the level of performance of Arizona's roads. One indicator particularly relevant to freight is the spatial relationship between truck volumes and congestion, shown previously in Figure 5.4. This relationship is determined first by calculating the volume-to-capacity ratio, which is the number of vehicles passing a certain point on a roadway over a given period divided by the capacity of that roadway over the same period. The volume-to-capacity ratio is typically measured during critical peak hours. Table 5.7 shows the volume-to-capacity ratio at the highest truck volume locations by county. The higher the ratio, the more congested the roadway. Table 5.8 shows the truck volumes at the most congested locations in the State.

Table 5.7 Volume-to-Capacity Ratio at Highest Truck Volume Locations by County, 2002

County	Interstate	Milepost	AADT	Total Number of Trucks	V/C Ratio
Maricopa	I-10	158.3	154,800	**54,200**	**0.89**
Pima	I-10	250.6	112,600	**42,900**	**1.00**
Coconino	I-40	197.9	41,600	**17,900**	**1.00**
Pinal	I-10	176.4	45,800	**15,900**	**0.80**
Mohave	I-15	2.0	22,200	**13,500**	**0.40**
Cochise	I-10	297.8	37,900	**12,000**	**0.71**
Navajo	I-40	251.7	24,200	**10,400**	**0.45**
Apache	I-40	319.6	26,600	**9,900**	**0.46**
Lapaz	I-10	45.4	22,300	**9,800**	**0.35**
Yavapai	I-17	47.6	35,300	**6,700**	**0.80**
Yuma	I-8	8.9	26,200	**3,900**	**0.55**
Santa Cruz	I-19	5.3	29,700	**3,300**	**0.56**

Source: Arizona Department of Transportation, Highway Performance Monitoring System, 2002.

Table 5.8 Truck Volumes at Locations with Highest Volume-to-Capacity Ratios by Interstate

County	Interstate	Milepost	AADT	V/C Ratio	Total Number of Trucks
Pima	I-10	257.8	148,700	**1.15**	**17,800**
Coconino	I-40	198.4	72,500	**1.50**	**31,200**
Coconino	I-17	337.4	97,300	**1.48**	**18,500**
Mohave	I-15	23.7	22,300	**0.46**	**13,600**
Pima	I-19	101.5	64,000	**0.94**	**5,800**
Yuma	I-8	2.2	60,400	**0.91**	**7,200**

Source: Arizona Department of Transportation, Highway Performance Monitoring System, 2002.

A combination of private logistics firms and freight logistics publications jointly has created a numerical ranking called a "logistics quotient" for 328 metropolitan areas around the country. As shown in Table 5.9, the rating system helps companies weigh the advantages and disadvantages of locating logistics facilities in various metropolitan areas. The rating system measures the performance of each metropolitan area based on a diverse range of freight-related characteristics, including road infrastructure, workforce, taxes, and fees. The methodology used to calculate each of the ratings is proprietary, and, therefore, should be used very generally to estimate how the private sector views different aspects of the freight transportation system. However, the rating system does allow for a general comparison of cities in Arizona with cities across the country.

The Flagstaff, Tucson, and Yuma areas rated fairly low overall on the scale, largely due to perceived deficiencies in the workforce. However, those areas' road infrastructure, in terms of road conditions and interstate highways, rated quite high. The freight railroad system and the lack of access to waterborne commerce are also seen as deficiencies in Arizona's freight transportation system.

Several other freight indicators require data collection and/or analysis beyond the scope of this work. These include:

- Average travel time between key freight activity centers (measure of recurrent congestion);
- Reliable travel time between key freight activity centers (e.g., 90 percent probability travel time);
- Peak-hour spreading of automobile activity;
- Mean and variance of speeds on key truck routes;
- Truck-involved crashes;
- Truck-rail split for select commodities (e.g., farm products); and
- Mean and variance of process time at border-crossing locations.

Collecting data on these freight performance indicators would allow for a comprehensive understanding of the various aspects of the freight transportation system in Arizona. Over time, this data could be used to determine which aspects of the freight transportation system are improving and which are not.

Table 5.9 Logistics Quotient for Selected Metropolitan Areas Across the U.S. and Arizona

2003 LQ Final Rank	Metropolitan Area	T&D Industry Metro Rank	Workforce Labor Metro Rank	Road Infra-structure Metro Rank	Road D/C/S Metro Rank	Road Condition State Rank	Interstate Highways Metro Rank	Taxes & Fees State Rank	Rail Road State Rank	Waterborne Commerce Metro Rank	Air Cargo Metro Rank
1	Savannah, GA	41	13	163	204	6	55	13	13	25	128
2	Nashville, TN	5	2	90	141	65	36	58	181	43	59
3	Atlanta, GA	9	9	299	130	6	13	13	13	197	1
4	Cleveland-Lorain-Elyria, OH	35	98	169	176	71	7	142	65	29	17
5	Toledo, OH	60	51	146	185	71	16	142	65	31	43
30	Los Angeles-Long Beach, CA	52	84	197	58	329	13	329	6	3	15
58	El Paso, TX	18	106	307	127	155	125	84	45	197	62
84	Sioux Falls, SD	79	94	209	19	232	55	142	303	197	51
85	**Phoenix-Mesa, AZ**	**107**	**154**	**247**	**18**	**52**	**85**	**219**	**264**	**197**	**40**
86	Riverside-San Bernardino, CA	67	164	151	24	329	55	329	6	197	69
96	Salt Lake City-Ogden, UT	216	101	254	80	135	24	206	200	197	8
109	Las Vegas, NV-AZ	171	102	272	34	26	125	280	196	197	49
110	Denver, CO	208	149	238	133	161	16	200	148	197	2
119	Albuquerque, NM	252	45	285	117	194	85	77	213	197	25
168	Alexandria, LA	113	138	95	284	290	160	45	84	197	241
169	**Flagstaff, AZ-UT**	**305**	**245**	**42**	**11**	**94**	**85**	**213**	**232**	**197**	**224**
170	Hamilton-Middletown, OH	136	48	276	265	71	160	142	65	197	289
171	**Tucson, AZ**	**181**	**274**	**250**	**59**	**52**	**85**	**219**	**264**	**197**	**68**
172	Newburgh, NY-PA	230	65	9	271	261	85	310	65	197	158
272	Dutchess County, NY	314	266	10	118	252	160	323	77	197	247
273	Las Cruces, NM	291	232	155	215	194	85	77	213	197	307
274	**Yuma, AZ**	**301**	**296**	**245**	**42**	**52**	**160**	**219**	**264**	**197**	**196**
275	Pocatello, ID	326	236	165	82	148	85	271	297	197	167
276	Fort Pierce-Port St. Lucie, FL	261	259	22	287	19	160	290	213	197	270

Source: Expansion Management + Logistics Today Magazines, Penton Media, Inc., 2003.

6.0 Institutional Environment for Goods Movement

6.0 Institutional Environment for Goods Movement

Goods movement in Arizona is subject to a number of Federal and state regulations. This section describes the primary institutions and legislative acts that regulate goods movement activity in the State.

6.1 Truck Size and Weight Restrictions

Several Federal and state regulations pertain to trucks because they operate on public roadways and share facility use with passenger cars. The size and weight of trucks have been regulated on Federal roads since the Federal-Aid Highway Act of 1956. Federal truck weight law applies to the interstate system, while Federal vehicle size law applies to the National Network, which includes the interstate system and several other roads as well. Current Federal truck size and weight (TS&W) law establishes the following limits:

- 20,000 pounds for single axles on the interstate;
- 34,000 pounds for tandem axles on the interstate;
- Application of a bridge formula for other axle groups up to the maximum of 80,000 pounds gross vehicle weight on the interstate;
- 102 inches for vehicle width on the National Network;
- 48-foot minimum for semi-trailers in a semi-trailer combination on the National Network; and
- 28-foot minimum for trailers in a twin-trailer combination on the National Network.

Federal law regulates trucks by specifying basic TS&W standards and exempting certain situations from those standards by recognizing state grandfather rights and special permits. In 1991, the Intermodal Surface Transportation Efficiency Act of 1991 (ISTEA) froze the maximum weight of longer combination vehicles and limited them to routes that were specified by the states. Long combination vehicles (LCVs) were defined as any combination of a truck tractor and two or more trailers or semi-trailers which operate on the National System of Interstate and Defense Highways with a gross vehicle rating greater

than 80,000 pounds. ISTEA also froze the length of trailers and semi-trailers, specifically cargo and carrying units.

Arizona has standard TS&W limits. The highest allowable gross vehicle weight rating is 80,000 pounds; single axles are limited to 20,000 pounds; and tandem axles are limited to 34,000 pounds. Arizona limits the length of semi-trailers to 57 feet on the interstate system, making the State one of 10 that allows semi-trailers over 53 feet in length. Truck weight limits are measured at truck weigh stations that are primarily located near the State's borders. Truck size limits can be enforced throughout the interstate system, but are most rigorously checked at the truck weigh stations. Vehicles found to be in violation of the TS&W limits are issued citations that include a fine.

ADOT is one of 34 states that issues overweight/oversize permits for some loads. These permits are issued to qualified applicants for specific loads with exact dimensions and exact weights. Class A oversize/overweight permits are issued for vehicle and load combinations that are within specific size and weight limits, in which the load cannot be otherwise separated into smaller loads. The Class A permit can be issued for either a single trip or 30 days. Class A permits are issued only for travel on the state routes. Permits for use for other routes are procured from the proper local authority, usually the county roads department. The following eligibility criteria must be met before issuing a Class A permit:

- Non-reducible (the load can not be separated into smaller loads);
- Specifically described load;
- The width of the vehicle and/or load is 14 feet or less;
- The height of the vehicle and/or load is 16 feet or less;
- The length of the vehicle and/or load is 120 feet or less;
- The combined weight of the vehicle and/or vehicle combination is 250,000 pounds or less;
- If the load projects from the side of the vehicle and the load is greater than or equal to 12 inches deep, the projection does not exceed three feet on either side;
- If the load projects from the side of the vehicle and the load is less than 12 inches deep, the projection does not exceed two feet on either side;
- Permit may not be used to routinely transport legal loads on over width trailers; and
- Vehicle must be currently registered for 80,000 pounds to be allowed to purchase an overweight permit.

6.2 Truck Routes

ADOT's web site maintains a list of road restrictions that is updated daily. Some road restrictions are only applicable to trucks and other large vehicles. Table 6.1 shows the *Road Restriction Report* as of January 20, 2004. Several jurisdictions in Arizona also have permanent lists of roads that are restricted from heavy truck use, and other recommended routes for trucks traveling between select origin-destination pairs.

Table 6.1 Arizona Road Restriction Report, 2004

	Width Restriction	Description
Tangerine Road	11' 0" wide	Restriction on Tangerine Road, Tucson
I-8	12' 0" wide	Eastbound milepost 36.0 east of Wellton through January 31, 2004
I-10	12' 0" wide	E/W bound milepost 2 – 12 detour route, exit 19 to B-10 to SR 95 to Indian Rt 1 to Poston Mohave Road to exit @ I-10 through April 30, 2004
I-15	10' 0" wide	N/S bound milepost 14 – 16, detour: Cedar City, UT to Las Vegas, NV/56 to 319 to 93 to I-15 through January 31, 2004
I-19	12' 0" wide	N/S bound milepost 61 – 64 (Tucson), effective through June 30, 2004
U.S. 60	11' 0" wide	E/W bound milepost 151 – 153 (Grand Avenue between 67th Avenue and 83rd Avenue), effective through July 12, 2004
SR 79	12' 0" wide	N/S bound milepost 100.9 – 106.4 North of SR 77 (escort vehicle required), through January 30, 2004
SR 95	10' 0" wide	N/S bound milepost 176 – 191 Lake Havasu Area, through March 31, 2004
SR 264	10' 0" wide	E/W bound milepost 381 – 382 second Mesa area, through February 28, 2004
SR 67	Closed for winter	N/S bound milepost 579.4 – 610.26 @ Grand Canyon, through May 14, 2004
SR 261	Closed for winter	N/S bound milepost 383 – 401.6 North of SR 273, through May 3, 2004
SR 273	Closed for winter	N/S bound milepost 383 – 396.9, through May 3, 2004
SR 366	Closed for winter	E/W bound milepost 136 – 136.3, effective through April 15, 2004
SR 473	Closed for winter	N/S bound milepost 0 @ SR 260 milepost 9 (Hawley Lake Road), through May 3, 2004

Source: Arizona Department of Transportation, 2004.

6.3 Truck Hours of Service

The amount of hours that a truck driver can drive consecutively is regulated by the U.S. DOT's Federal Motor Carrier Safety Administration (FMCSA). These new rules, effective as of January 4, 2004, are the first substantial change the FMCSA has made to the truck driver hours-of-service rules (HOS) since 1939. This rule governs drivers transporting freight in interstate commerce in a property-carrying commercial vehicle with a gross vehicle weight rating of 10,001 pounds or more, and operating vehicles transporting hazardous materials in quantities requiring vehicle placards.

The new rules allow drivers to drive 11 hours after 10 consecutive hours off duty. Also, drivers may not drive beyond the 14th hour after coming on duty, following 10 hours off duty. Similar to existing rules, drivers may not drive after being on duty for 60 hours in a seven-consecutive-day period or 70 hours in an eight-consecutive-day period. This on-duty cycle may be restarted whenever a driver takes at least 34 consecutive hours off duty. The current rule allows 10 hours of driving within a 15-hour on-duty period after eight hours of off-duty time. Also, drivers may not drive after their 15th hour on duty in a workday or after 60 hours on duty in seven consecutive days or 70 hours on duty in eight consecutive days.

Short-haul truck drivers – those drivers who routinely return to their place of dispatch after each duty tour, and then are released from duty – may have an increased on-duty period of 16 hours once during any seven-consecutive-day period. The 16-hour exception takes into consideration legitimate business needs without jeopardizing safety. FMCSA estimates that without the extra two on-duty hours, the industry would be required to hire at least 48,000 new drivers, actually reducing crash-reduction benefits.

The intention of the rule change is to improve highway safety and help reduce the number of truck crashes and related fatalities and injuries by addressing commercial motor vehicle (CMV) driver fatigue. The FMCSA estimates the new rule will save up to 75 lives and prevent as many as 1,326 fatigue-related crashes annually. There were an estimated 4,902 truck-related fatalities in traffic crashes in 2002. The impact on motor carrier operations is that more truck drivers will be needed by companies that perform long-haul trucking operations. This will increase the cost of transporting goods long distance. In addition, more stops will be made by trucks on long-haul routes. Since Arizona has a large amount of through truck traffic that includes several long-haul trips, it is likely that there will be more stops in the State of Arizona by these trucks that perform through trips.

Vehicles used in oil-field operations, groundwater well-drilling operations, utility service, and transporting construction materials and equipment retain the 24-hour restart provision provided by the National Highway System Designation Act. Agricultural operations will retain their current statutory exemption from driving time requirements when occurring within a 100-air-mile radius of a farm or distribution point during planting and harvesting seasons.

6.4 Border Crossing Regulations

Goods crossing the nation's borders have been subject to several regulations for many years. The regulations have intensified in the last few years due to increased concerns about terrorism. Arizona operates 20 fixed ports of entry throughout the State, in addition to the main commercial permits office. Six of the ports are international border ports. Each of the border crossing locations operates a port of entry program, which mission is to ensure that all commercial vehicles operating on Arizona highways have proper credentials and are in safe operating condition, while providing efficient, fair, and friendly treatment to all of the customers and citizens of Arizona. Arizona ports of entry monitor and screen all commercial traffic entering the State of Arizona for registration, motor tax, size and weight restrictions, commercial driver's license requirements, insurance requirements, and motor carrier equipment safety requirements.

6.4.1 Trade Act of 2002

Section 343 of the Trade Act of 2002 includes a requirement that electronic cargo information on international goods be passed from the carrier to Customs prior to the goods arriving at the border-crossing location. The advance notification depends on the mode of transportation. Table 6.2 shows the advance time needed and the data system requirements by mode. This Trade Act will have a particular impact on Arizona goods movement.

Arizona-Mexico trucking is handled through a network of U.S.-based trucking firms that transport the goods between their final U.S. location and the U.S. side of the border. The actual border crossing truck activity is generally performed by specialty trucking firms that are primarily based in Mexico and operate on slim margins with limited technology. Therefore, a significant upgrade of equipment is likely needed by these firms to comply with the advance notification rule. In addition, a large portion of the agricultural goods that cross the Arizona-Mexico border are currently handled using last minute orders by shippers to carriers. This reduces the window of opportunity of carriers to notify Customs regarding the type of goods and the estimated time of arrival to the Customs location. This new rule is likely to create significant logistical obstacles for imported goods, and eventually increase the price of transporting these goods.

Table 6.2 Summary of Requirements for Advance Electronic Cargo Information

Mode	In/ Out	Data System	Transmittal Timeframes		Responsible Parties	Length of Transition Period After Publication of Final Rule
			NPRM	Final Rule		
Air & Courier	In	Air AMS	a. 4 hrs, or b. "Wheels up" from certain nearby areas prior to arrival in U.S.	Same as NPRM	a. Air carriers b. Importer or its broker c. Freight forwarder d. Express consignment facility e. Other air carriers	90 days. However, CBP could delay the implementation at a given port until the necessary training has been provided to CBP personnel at that port. Also, CBP could delay the effective date if any essential programming changes to the approved data interchange system were not in place.
	Out	AES	2 hrs prior to departure from U.S.	Same as NPRM	Exporter	Current AES exporter reporting requirements will be employed on an interim basis until the AES Commodity Redesign Project is developed pursuant to Census regulations due to be issued in 2004.
Rail	In	Rail AMS	2 hrs prior to arrival in U.S.	Same as NPRM	Rail carrier	90 days after rail AMS is operational at port.
	Out	AES	4 hrs prior to attachment of engine before going foreign	2 hrs prior to arrival at the border	Exporter	Current AES exporter reporting requirements will be employed on an interim basis until the AES Commodity Redesign Project is developed pursuant to Census regulations due to be issued in 2004.

Table 6.2 Summary of Requirements for Advance Electronic Cargo Information (continued)

Mode	In/ Out	Data System	Transmittal Timeframes		Responsible Parties	Length of Transition Period After Publication of Final Rule
			NPRM	Final Rule		
Vessel	In	Vessel AMS	24 hrs prior to lading at foreign port	Same as NPRM	a. Vessel carriers b. NVOCCs	Parties to be automated on vessel AMS within 90 days at all ports where their vessels arrive.
	Out	AES	24 hrs prior to departure	24 hrs prior to departure from U.S. port where cargo is laden	Exporter	Current AES exporter reporting requirements will be employed on an interim basis until the AES Commodity Redesign Project is developed pursuant to Census regulations due to be issued in 2004.
Truck	In	FAST, PAPS, BRASS, or CAFES	a. FAST: 30 mins b. Non-FAST: 1 hr prior to arrival in U.S.	Same as NPRM	a. Truck carriers b. Importer c. Customs broker	90 days from the date CBP has officially notified affected carriers by *Federal Register* publication that an approved data interchange is in place and fully operational.
	Out	AES	1 hr prior to border crossing	Same as NPRM	Exporter	Current AES exporter reporting requirements will be employed on an interim basis until the AES Commodity Redesign Project is developed pursuant to Census regulations due to be issued in 2004.

Source: http://www.azfuel.com/mvd/commercialenforcement/document/RoadRestrictionReport.pdf.

6.4.2 Customs-Trade Partnership Against Terrorism

Customs-Trade Partnership Against Terrorism (C-TPAT) is a government-industry partnership program designed to increase security at the nation's borders. Industry participation is on a voluntary basis. After completing a comprehensive survey of the cargo security aspects of their supply chain from foreign point of origin through delivery to U.S. consignee, companies sign an Agreement to Voluntarily Participate (AVP), complete a Supply Chain Security Questionnaire, and submit these to Customs. Before the required application and questionnaire can be completed, a comprehensive evaluation of security procedures, training, and recordkeeping must be undertaken by the company to ensure that the protocols are in line with Customs C-TPAT standards.

Currently, C-TPAT is open to importers, transportation providers, and brokers. Customs plans to expand C-TPAT's scope to include other vendors and exporters in the future. Customs hopes to create a community of C-TPAT-approved companies. Customs has provided a matrix of standards and will continue to develop the methodology over time in reaction to various situations that occur. Customs has published minimum requirements that must be met by companies seeking C-TPAT certification. C-TPAT is open to all importers. However, there is no guarantee of admission. Importers that are considered to be high risk may be declined admission to the C-TPAT program.

The importer is required to ensure that all suppliers of materials, services, and transportation, both internally and externally, are fully compliant with C-TPAT guidelines. These outside service providers include brokers, carriers, freight forwarders, and other partners.

Customs has proposed some concrete benefits to companies that participate in this program. Included in these are the following:

- Reduced Customs inspections;
- Reduced border delays;
- Entitlement to a Customs account manager; and
- Eligibility for account-based processes.

Shippers that do not participate in the C-TPAT program are likely to experience increased inspections, increased border waiting time, exclusion from the next generation of Customs partnership programs, and potentially negative publicity from failure to act with due diligence in the event of a catastrophic event associated with the supply chain. The C-TPAT program is one of continuous improvement. If there are shortfalls, companies will design action plans, with the assistance of their Customs account managers that reflect their C-TPAT commitments. Companies will be able track their progress in fulfilling the required security improvements.

6.4.3 Free and Secure Trade Implementation on U.S.-Mexico Border

The Free and Secure Trade (FAST) program is a trade program that has recently been extended to the U.S.-Mexico border from its previous operations exclusively at the U.S. – Canada border. The FAST program is a direct outgrowth of the Smart Border Accords entered into between the U.S. and Canada and the U.S. and Mexico in the wake of the terrorist attacks of September 11, 2001. The FAST program uses common risk-management principles, supply chain security, industry partnerships, and advanced technology to improve the efficiency of screening and clearing commercial traffic at ports of entry along the U.S.-Canada and U.S.-Mexico borders.

The FAST program aims to ensure – and expedite – the legitimate flow of goods and people across the United States' northern and southern borders, thereby, enhancing security, while also facilitating trade. Participants qualify by enhancing the security of their manufacturing plants, warehouses, and shipping systems under the auspices of the U.S. C-TPAT. FAST processing on the U.S.-Mexico border also requires the foreign manufacturer to use high-security seals properly placed in the approved manner when crossing the border.

The first dedicated FAST lanes on the U.S.-Mexico border opened on December 4, 2003, in El Paso, Texas. FAST lanes will be opened at additional ports of entry on the U.S.-Mexico border within the next few months, according to the Department of Homeland Security. The government of Mexico has committed to designate special FAST access lanes from Mexico where the local highway infrastructure allows. As of November 25, 2003, CBP received 1,153 driver applications. CBP has issued FAST identification cards to 974 of these commercial truck drivers at the El Paso FAST Driver Enrollment Center. Nearly 3,000 trucks have been processed through the FAST lanes in El Paso since October 27, 2003.

6.4.4 Bioterrrorism Act of 2002

The Bioterrorism Act of 2002 was enacted to improve the ability of the U.S. to prevent, prepare for, and respond to bioterrorism and other public health emergencies. This Act included three main components, including:

1. To increase the national preparedness for bioterrorism and other public health emergencies;

2. To enhance the controls on dangerous biological agents and toxins; and

3. To protect the safety and security of the food and drug supply.

This Act also sets forth a specific set of rules that require the U.S. Food and Drug Administration (FDA) to be given advance notification of the shipments of imported food.

One of the specific regulations developed as a result of this act is the requirement for registration of all food facilities serving the U.S. market. This includes a requirement that domestic and foreign facilities that manufacture, process, pack, or hold food for human or animal consumption in the United States must register with FDA by December 12, 2003. As mentioned earlier, Arizona has a large agricultural industry and imports a significant amount of agricultural products from Mexico. Therefore, this registration process and the special notification requirements are likely to lead to an increase in prices for these goods.

6.5 Air Quality

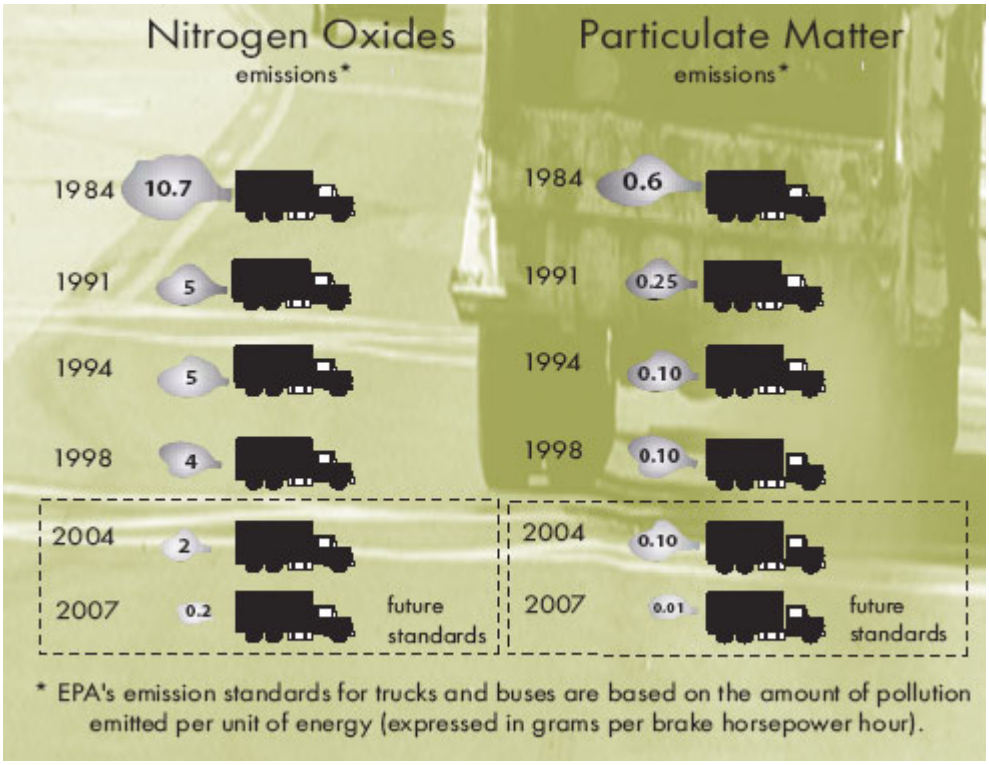
6.5.1 Federal Regulations

Emissions of goods-carrying vehicles (including diesel engines and locomotives) contribute to the overall emissions inventory. There have been several steps at the national and local level to reduce the emissions from these vehicles as part of larger air quality goals. The U.S. Environmental Protection Agency (EPA) sets emissions limits for these vehicles by limiting the amount of emissions of carbon monoxide (CO), nitrogen dioxide (NO_2), ozone (O_3), particulate matter (PM), and sulfur dioxide (SO_2).

At the agency level, the emission limits for the diesel engines used in most heavy-duty trucks are being reduced. However, because heavy-duty trucks have a longer life cycle than passenger cars, many engines in the existing fleet will be in operation for another 25 to 30 years. The old and new regulations for NO_2 and PM emissions are shown in Figure 6.1. The new regulations have increased the cost of diesel engines; therefore, many motor carriers are delaying the purchase of new trucks as long as possible, partially through retrofitting the engines of older vehicles. As a direct impact to this policy, there will be a larger proportion of older trucks on the road in the near future. Other programs being run by the EPA to control heavy-duty emissions include the retrofitting of existing diesel vehicles with pollution controls, implementation of emissions testing programs for diesel vehicles, creation and implementation of anti-idling programs, and the promotion of cleaner fuels like ultra-low sulfur diesel and compressed natural gas.

In addition, by 2006, diesel fuel will be required to contain 97 percent less sulfur than in 2003. This ultra-low sulfur diesel fuel, in combination with advanced pollution control technology, will mean that, in 2007, new trucks and buses rolling off the production lines will be up to 95 percent cleaner than today's models.

Figure 6.1 EPA Standards for New Trucks and Buses



Source: U.S. Environmental Protection Agency.

6.5.2 Emissions in Arizona

Pollutant levels are measured in each metropolitan area and compared to the National Ambient Air Quality Standards. Regions that are found to have emissions levels that do not meet EPA standards are found to be in nonattainment. The regions in Arizona which are in nonattainment as of July 20, 2000 are shown in Table 6.3.

As part of an effort to reduce and regulate diesel emissions, all 1967 and newer diesel-powered vehicles registered within the emissions control areas of Phoenix and Tucson are required to be emissions tested annually. The only exception is for apportioned vehicles, which are commercial vehicles that are licensed in multiple states. Diesel vehicles pulling trailers will not be accommodated at the inspection stations.

Heavy-duty diesel vehicles (vehicles with gross vehicle weight rating above 8,500 pounds) in Maricopa County are tested using the Society of Automotive Engineers J1667 test protocol, commonly referred to as the "snap-acceleration test." Diesel-powered vehicles may be tested at any of the vehicle emissions inspection stations in Maricopa County. In Pima County, heavy-duty diesel vehicles with 26,000 pounds gross vehicle weight or greater or any truck with tandem drive axles must be tested at a particular location within the County.

Table 6.3 Arizona Nonattainment Areas by County and Pollutant, 2004

	Pollutant				
County	**CO**	**PM_{10}**	**SO_2**	**Ozone (1 Hour)**	**Ozone (8 Hours)**
Cochise		Moderate	Primary		
Gila		Moderate	Primary		
Greenlee			Primary		
Maricopa	Serious	Serious		Serious	Non-attainment
Mohave					
Pima	Maintenance	Moderate			
Pinal		Serious	Primary		Non-attainment
Santa Cruz		Moderate			
Yuma		Moderate			

Source: Environmental Protection Agency, May 2004. Nonattainment areas generally include only parts of counties.

7.0 Critical Freight Transportation Findings

7.0 Critical Freight Transportation Findings

There are four critical freight transportation findings from this study that can be used to develop broad themes to guide future freight and goods movement planning in Arizona. These include:

1. **Goods movement is a critical part of Arizona's economy.**

Approximately 74 percent of the economic output and 42 percent of the employment in Arizona are in transportation-dependent industries. In terms of dollars of output, the electronics industry represents 32 percent of all of the goods-producing industries in the State, by far the largest of any industry. Electronics is also the fastest growing of the transportation-dependent industries, so its dominant share of Arizona's economic output will increase in the future. The electronics industry relies heavily on the air and truck modes for transporting its goods. Therefore, transportation planners should consider the preservation of highway access for air cargo to the State's cargo airports as a priority.

2. **Future capacity of the State's transportation system should match the logistics trends of Arizona's primary industries.**

Of the 122 million tons of goods output in Arizona, the top four commodities (nonmetallic mineral products, coal, metallic ores and concentrates, and natural sands) represent 41 percent of total movements. These commodities are primarily used in light and heavy construction to support Arizona's growing population. The industries that produce these commodities rely on a mix of truck and rail to move their goods. The truck and rail industry infrastructure must ensure that it has the capacity to match the logistics trends of these industries. Over one-third of the total tonnage moved in Arizona has both an origin and a destination in the Phoenix metropolitan area, so Phoenix's intraregional highway infrastructure is a critical component of the State's goods movement infrastructure.

3. **Through truck movements constitute a significant portion of Arizona's total goods movement activity and further confirm the need for continued multi-state freight planning.**

There are over 40 million tons of domestic through truck trips using Arizona's transportation system. These movements equate to roughly 16 billion annual ton-miles from through truck traffic in the State. This is 40 percent of the total ton-miles for the non-through trips (internal trips, internal-external trips, and external-internal trips) of all modes. An additional six million tons of through truck flows are goods that are imported or exported through the El Paso border crossing and connecting with California. This

high percentage of through truck trips underscores the need for Arizona to partner with neighboring states in multi-state planning efforts that will improve goods movement for the region.

4. Exports and international trade will account for a significant portion of Arizona's growing, future economy.

In 2002, Arizona exported $11.9 billion of goods to other countries, approximately 12 percent of the total goods output for the State. International trade is also the fastest growing segment of the Arizona economy. Mexico is Arizona's largest international trade partner with $3.0 billion of exported goods, and the Maquiladoras constitute a large fraction of this trade. High-value goods, such as electrical and other machinery, constitute the largest portion of the Mexico-Arizona trade by value. Agricultural products are the largest portion of these goods by tonnage. I-19 between Nogales and Tucson is the portion of the Arizona transportation system that is most heavily affected by international flows, with 70 percent of the truck volume on the interstate being generated by international moves. International shippers along the Arizona-Mexico border have also cited an efficient transportation system as important for the continued growth of international trade.